e2v

# ELIIXA+ 16k

## Cmos Multi-Line Monochrome Camera

# User Manual

# Summary

*1 CAMERA OVERVIEW ..... 4*
1.1 Features ..... 4
1.2 Key Specifications ..... 4
1.3 Description ..... 5
1.4 Typical Applications ..... 5
*2 CAMERA PERFORMANCES ..... 6*
2.1 Camera Characterization ..... 6
2.2 Image Sensor ..... 7
2.3 Multi-Lines modes ..... 7
2.4 Response & QE curves ..... 8
2.4.1 Quantum Efficiency ..... 8
2.4.2 Spectral Response ..... 8
*3 CAMERA HARDWARE INTERFACE ..... 9*
3.1 Mechanical Drawings ..... 9
3.2 Input/output Connectors and LED ..... 10
3.2.1 Power Connector ..... 11
3.2.2 Status LED Behaviour ..... 12
3.2.3 CameraLink Output Configuration ..... 12
*4 STANDARD CONFORMITY ..... 13*
4.1 CE Conformity ..... 13
4.2 FCC Conformity ..... 13
4.3 RoHs Conformity ..... 13
*5 GETTING STARTED ..... 15*
5.1 Out of the box ..... 15
5.2 Setting up in the system ..... 15
*6 CAMERA SOFTWARE INTERFACE ..... 16*
6.1 Control and Interface ..... 16
6.2 Serial Protocol and Command Format ..... 17
6.2.1 Syntax ..... 17
6.2.2 Command Processing ..... 17
6.2.3 GenICam ready ..... 17
6.3 Camera Commands ..... 18
6.3.1 Information ..... 18
6.3.2 Image Format ..... 21
6.3.3 Acquisition Control ..... 27
6.3.4 Gain and Offset ..... 29

6.3.5 Flat Field Correction ..... 31
6.3.5.1 Activation and Auto-Adjust ..... 33
6.3.5.2 Automatic Calibration ..... 34
6.3.5.3 Manual Flat Field Correction ..... 35
6.3.5.4 FFC User Bank Management ..... 36
6.3.6 Look Up Table ..... 38
6.3.7 Statistics and Line Profile ..... 40
6.3.8 Privilege Level ..... 41
6.3.9 Save & Restore Settings ..... 42

***7 APPENDIX A: Test Patterns ..... 43***
7.1 Test Pattern 1: Vertical wave ..... 43
7.2 Test Pattern 2: Fixed Horizontal Ramps ..... 43
7.2.1 In 8 bits (Full) format – No Binning (16384 pixels) ..... 43
7.2.2 In 12 bits (Medium) format – No Binning (16384 pixels) ..... 44
7.2.3 In 8/12 bits Full/Medium format with Binning (8192 Pixels) ..... 45

***8 APPENDIX B: Timing Diagrams ..... 46***
8.1 Synchronization Modes with Variable Exposure Time ..... 46
8.2 Synchronisation Modes with Maximum Exposure Time ..... 47
8.3 Timing Values ..... 48
8.3.1 EV71YC4MCL1605-BA0 version ..... 48
8.3.2 EV71YC4MCL1605-BA1 version ..... 48

***9 APPENDIX C: Thermal Management ..... 49***
9.1 Heat Sink ..... 49

***10 APPENDIX D: Data Cables ..... 49***
10.1 CameraLink ..... 49

***11 APPENDIX E: Lenses Compatibility ..... 50***

***12 APPENDIX F: TROUBLESHOOTING ..... 51***
12.1 Camera ..... 51
12.2 CommCam Connection ..... 51

***13 APPENDIX G: Revision History ..... 52***

# 1 CAMERA OVERVIEW

## 1.1 Features

- Cmos Sensor 4x 16384 Pixels, 5 x 5µm
- Multi-Line structure (1, 2 or 4 lines to adapt the sensitivity)
- Interface :
  - Medium/Full CameraLink®, 85MHz per Channel
  - Full+ (10 Taps) CameraLink®, 85MHz per Channel, for "**BA1**" versions only
- Line Rate :
  - Up to 50000 l/s In CameraLink® for "**BA1**" versions
  - Up to 40000 l/s In CameraLink® for "**BA0**" versions
- Data Rate :
  - Up to 850 MB/s In CameraLink®
- Bit Depth : 8 or 12bits
- Flat Field Correction
- Look Up Table
- Low Power Consumption : <13W
- Compliant with Standard Lenses of the Market

## 1.2 Key Specifications

Note : All values in LSB is given in 12 bits format

| Characteristics | Typical Value | Unit |
|---|---|---|
| **Sensor Characteristics at Maximum Pixel Rate** | | |
| Resolution | 4 x 16384 | Pixels |
| pixel size (square) | 5 x 5 | µm |
| Max line rate – CameraLink Full+ 10 x 85MHz | 50 (*) | kHz |
| Max line rate – CameraLink Full 8 x 85MHz | 40 | |
| Max line rate – CameraLink Medium 4 x 85MHz | 20 | |
| **Radiometric Performance at Maximum Pixel Rate and minimum camera gain** | | |
| Bit depth | 8, 12 | Bits |
| Response (broadband) | 450 | LSB/(nJ/cm²) |
| Full Well Capacity | 27300 (in 2S or 4S mode and MultiGain at 1/2) | electrons |
| Response non linearity | 0,3 | % |
| PRNU HF Max | 3 | % |
| Dynamic range (1S / 2S / 4S mode) | 67,6 / 70,7 / 68,7 | dB |

(*) Not available for EV71YC4MCL1605-**BA0** versions

| | | |
|---|---|---|
| **Functionality (Programmable via Control Interface)** | | |
| Analog Gain | Up to 12 (x4) | dB |
| Offset | -4096 to +4096 | LSB |
| Trigger Mode | Timed (Free run) and triggered (Ext Trig, Ext ITC) modes | |
| **Mechanical and Electrical Interface** | | |
| Size (w x h x l) | 100 x 156 x 36 | mm |
| Weight | 700 | g |
| Lens Mount | M95 x 1 | - |
| Sensor alignment ( see chapter 4 ) | ±100 | µm |
| Sensor flatness | ±35 | µm |
| Power supply | Single 12 DC to 24 DC | V |
| Power dissipation - CameraLink | < 13 | W |
| **General Features** | | |
| Operating temperature | 0 to 55 (front face) or 70 (Internal) | °C |
| Storage temperature | -40 to 70 | °C |
| Regulatory | CE, FCC and RoHS compliant | |

## 1.3 Description

e2v's next generation of line scan cameras are setting new, high standards for line rate and image quality. Thanks to e2v's recently developed multi line CMOS technology, the camera provides an unmatched 100 000 lines/s in a 16k pixel format and combines high response with an extremely low noise level; this delivers high signal to noise ratio even when short integration times are required or when illumination is limited. The 5µm pixel size is arranged in four active lines, ensuring optimal spatial resolution in both scanning and sensor directions with off-the-shelf lenses. This Camera opens up an array of new possibilities for the next generation of inspection systems for demanding applications such as flat panel display, PCB and solar cell inspection.

## 1.4 Typical Applications

- Flat Panel Display Inspection
- PCB Inspection
- Solar Cell Inspection
- Glass Inspection
- Print Inspection

# 2 CAMERA PERFORMANCES

## 2.1 Camera Characterization

| | Unit | Mode 1S (0dB) | | | Mode 2S (0dB) | | | Mode 4S (0dB) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Typ. | Max | Min | Typ. | Max | Min | Typ. | Max |
| **Dark Noise RMS** | LSB | - | 1,7 | 2,2 | | 2,4 | 3,1 | | 3 | 4 |
| **Dynamic Range** | - | - | 2394:1 | - | - | 3412:1(*) | - | - | 2730:1(*) | - |
| **Readout Noise** | e- | - | 5,7 | - | - | 8 | - | - | 10 | - |
| **Full Well Capacity** | e- | - | 13650 | - | - | 27300 | - | - | 27300 | - |
| **SNR** | dB | - | 40 | - | - | 43(*) | - | - | 43(*) | - |
| **Peak Response** (660nm) | LSB/ (nJ/cm2) | - | 137 | - | - | 274 | - | - | 547 | - |
| **Non Linearity** | % | - | 0,3 | - | - | 0,3 | - | - | 0,3 | - |
| ***Without Flat Field Correction :*** | | | | | | | | | | |
| **FPN rms** | LSB | - | 0,4 | 1,5 | - | 0,7 | 1,5 | - | 0,8 | 1,5 |
| **FPN pk-pk** | LSB | - | 3,2 | 15 | - | 5 | 15 | - | 5,6 | 15 |
| **PRNU hf** (3/4 Sat) | % | - | 0,13 | 0,25 | - | 0,1 | 0,25 | - | 0,1 | 0,25 |
| **PRNU pk-pk** (3/4 Sat) | % | - | 1 | 3 | - | 0,8 | 3 | - | 0,8 | 3 |

Test conditions :

- Figures in LSB are for a 12bits format.
- Measured at exposure time = 50µs and line period = 50µs in Ext Trig Mode (Max Exposure Time)
- Maximum data rate
- Stabilized temperature 30/40/55 °C (Room/Front Face/Internal)
- SNR Calculated at 75% Vsat with minimum Gain.

(*) In mode 2S/4S, only with the use of the Multi-Line Gain


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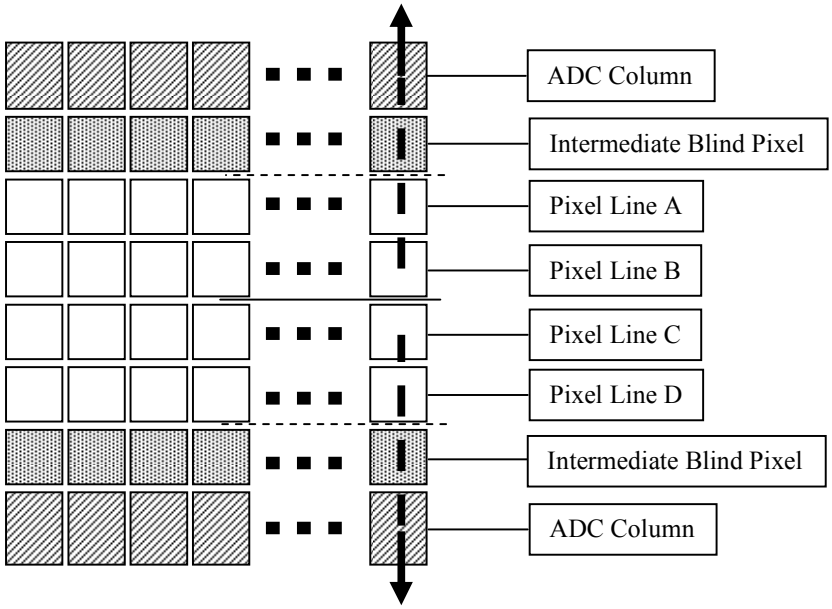
## 2.2 Image Sensor

The Eliixa+ 16k sensor is composed of two pairs of sensitive lines. Each pair of lines use the same Analog to Digital Column converter (ADC Column). An appropriate (embedded) Time delay in the exposure between each line this allows to combine two successive exposures in order to double the sensitivity of a single line.

This Time Delay Exposure is used only in the 4S multi-line modes (4 Lines) as described below.

The 16384 Pixels of the whole sensor are divided in 4 blocks of 4096 pixels.




## 2.3 Multi-Lines modes

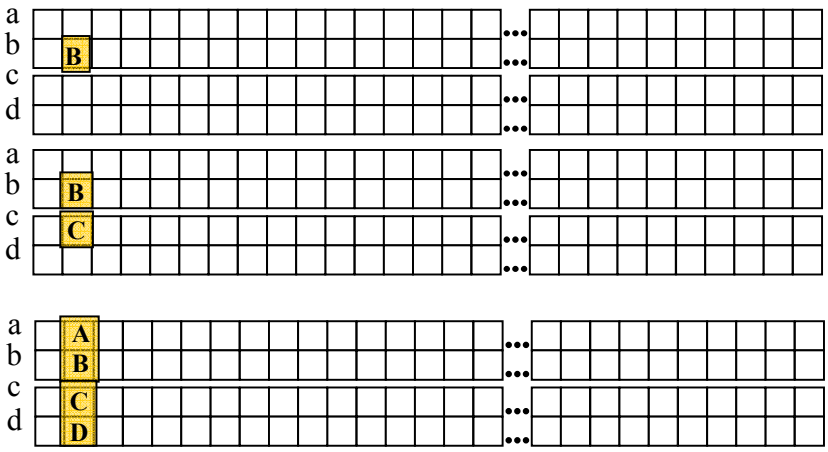
**Multi-Lines Modes** *(16k Pixels Output)*

Mode 1S = B

Mode 2S = B+C (FPGA)

Mode 4S = (A.B)+(C.D)

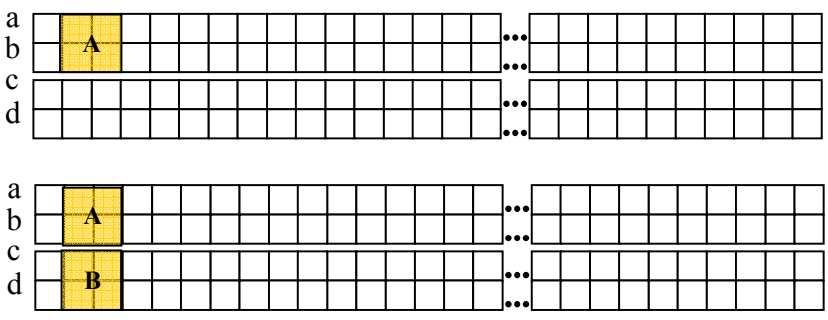
Note : (A.B) = summation in the sensor




**Binning Modes** *(8k Pixels Output)* : *Not available on EV71YC4MCL1606-**BA0** versions*

Mode 1SB = A

Mode 2SB = (A+B)





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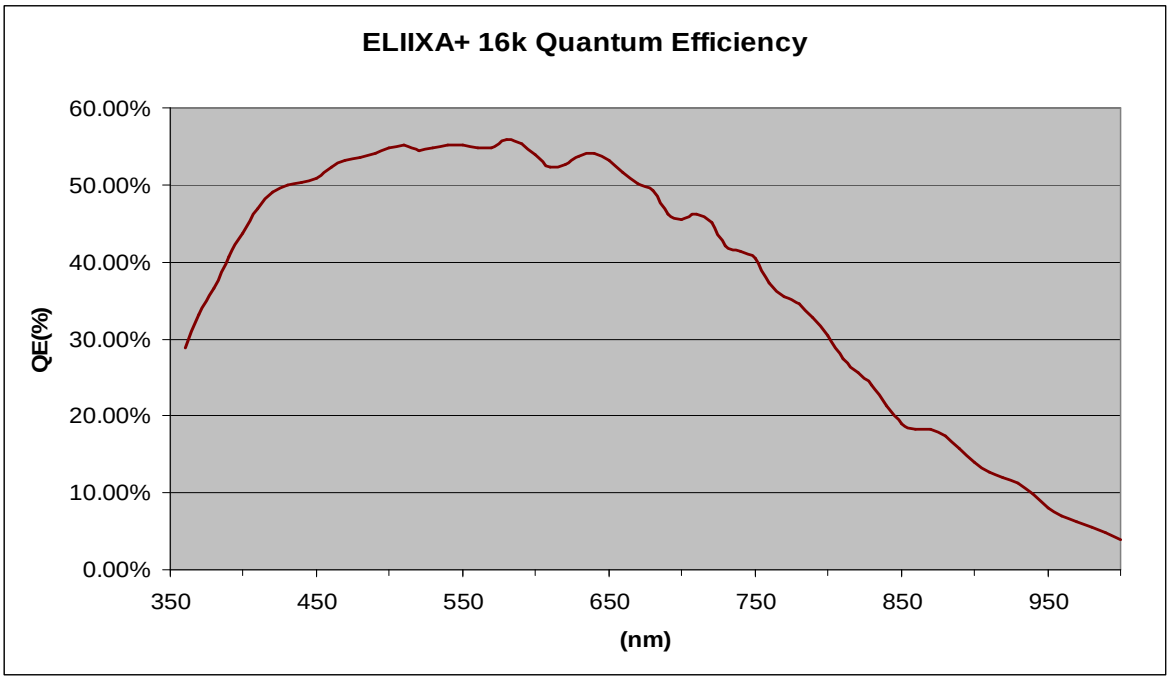
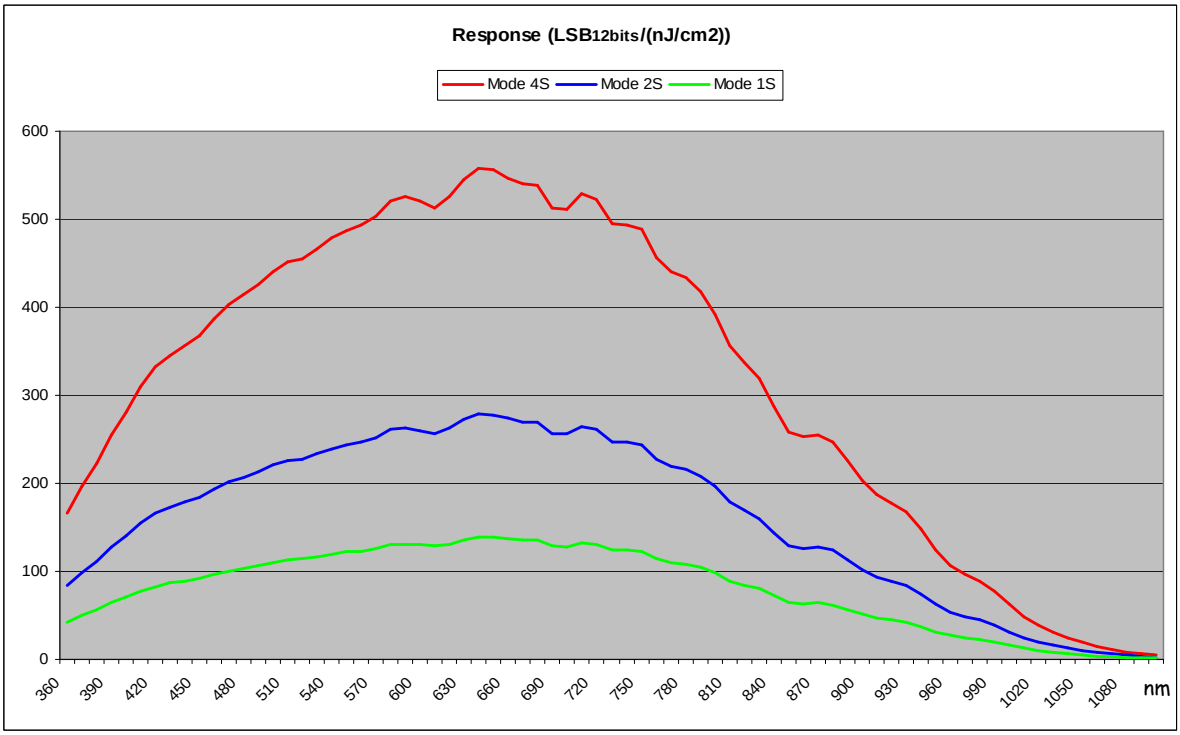
## 2.4 Response & QE curves

### 2.4.1 Quantum Efficiency

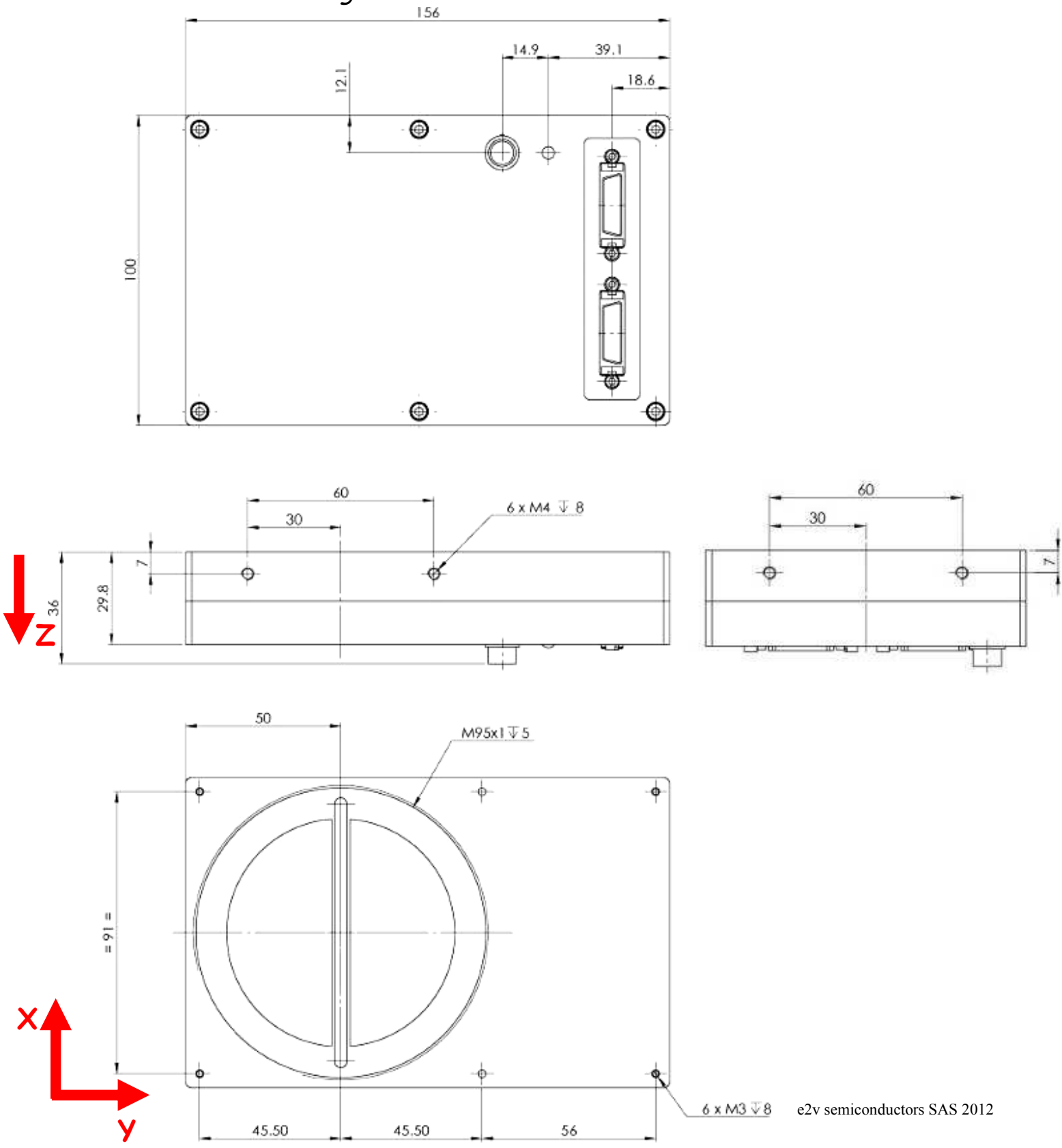



### 2.4.2 Spectral Response



# 3 CAMERA HARDWARE INTERFACE

## *3.1 Mechanical Drawings*

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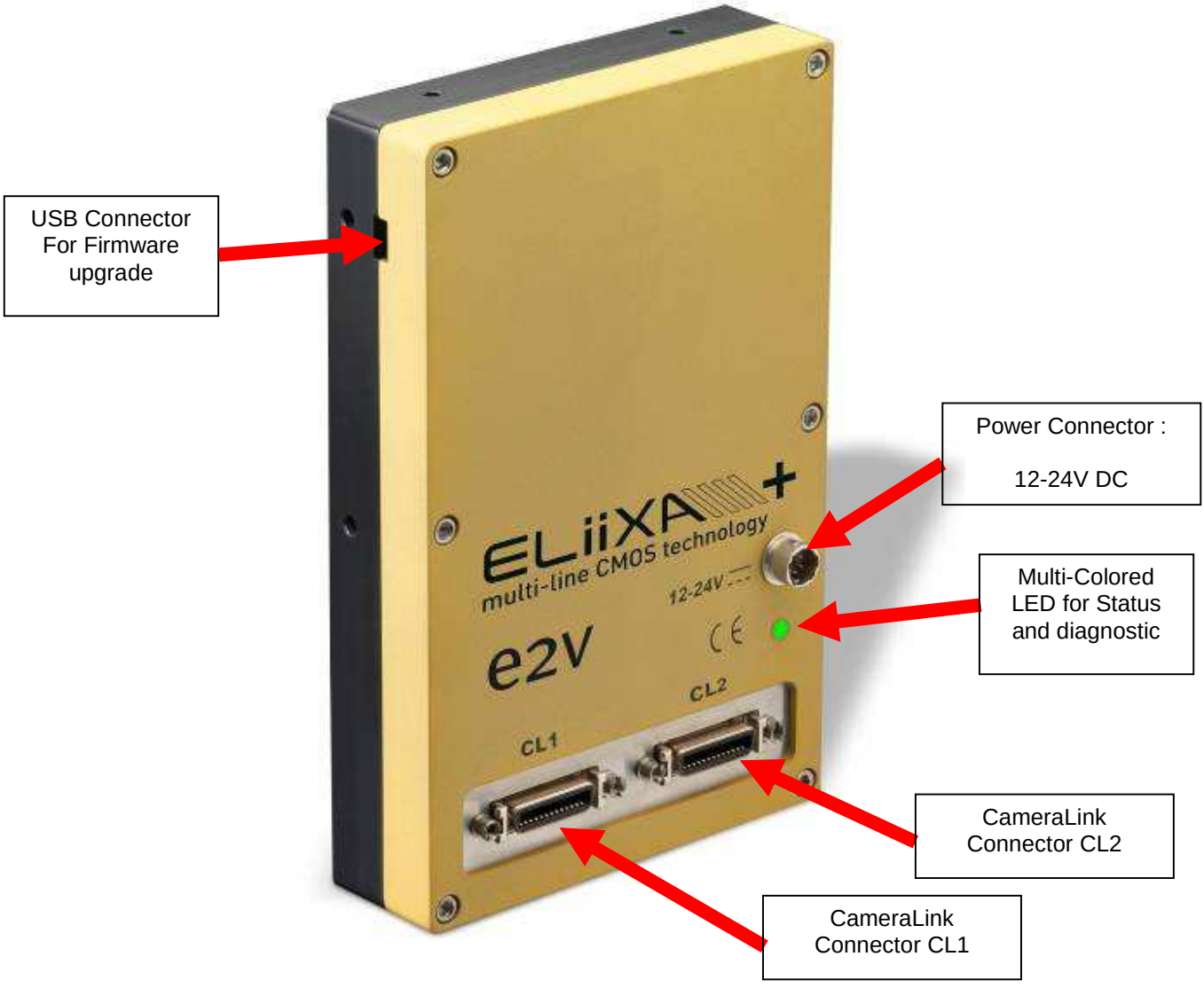
| Sensor alignment | |
|---|---|
| Z = -9.4 mm | ±100µm |
| X = 9 mm | ±100 µm |
| Y = 50mm | ±100 µm |
| Flatness | ±25 µm |
| Rotation (X,Y plan) | ±0,1° |
| Tilt (versus lens mounting plane) | 50µm |

## 3.2 Input/output Connectors and LED





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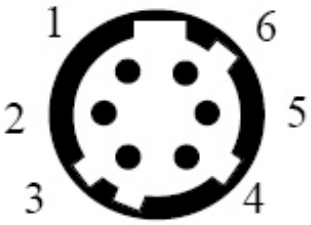
### 3.2.1 Power Connector

Camera connector type: Hirose HR10A-7R-6PB (male)
Cable connector type: Hirose HR10A-7P-6S (female)



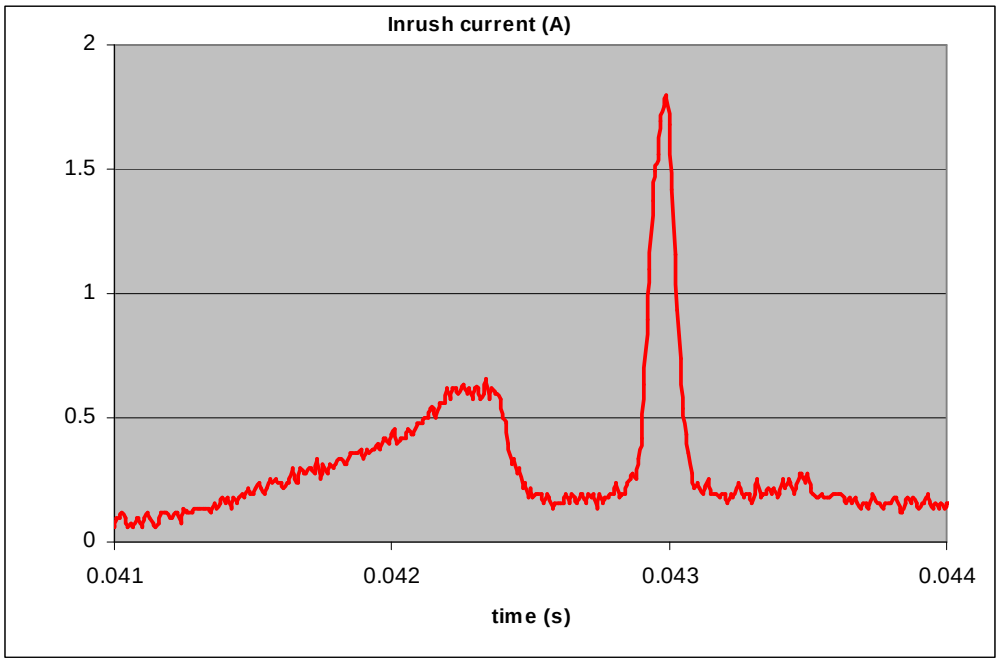

Camera side description

| Signal | Pin | Signal | Pin |
|---|---|---|---|
| PWR | 1 | GND | 4 |
| PWR | 2 | GND | 5 |
| PWR | 3 | GND | 6 |

Power supply from 12 to 24v
Power 13W max with an typical inrush current peak of **1,8A** during power up

| Typical values | Current consumption | |
|---|---|---|
| | **12V** | **24V** |
| **ELIIXA+ CL (normal)** | 1,06A | 0,54A |
| **ELIIXA+ CL (Standby)** | 0,47A | 0,25A |

**Power up Time** : Around 43s (Green Light)



### 3.2.2 Status LED Behaviour

After less than 2 seconds of power establishment, the LED first lights up in ORANGE. Then after a Maximum of 30 seconds, the LED must turn in a following colour :

| Colour and state | Meaning |
|---|---|
| **Green** and continuous | OK |
| **Green** and blinking slowly | Waiting for Ext Trig (Trig1 and/or Trig2) |
| **Red** and continuous | Camera out of order : Internal firmware error |

### 3.2.3 CameraLink Output Configuration

| | Connector CL1 + CL2 | Pixels per Channel |
|---|---|---|
| **Medium CameraLink Mode** | | |
| 4 Channels 8bits | 4 x 85MHz | 4 x 4096 |
| 4 Channels 12bits | 4 x 85MHz | 4 x 4096 |
| **Full CameraLink Mode** | | |
| 8 Channels 8bits | 8 x 85MHz | 8 x 2048 |
| **Full + CameraLink Mode** (not available for EV71YC4MCL1605-**BA0** versions) | | |
| 10 Channels 8bits | 10 x 85MHz | 10 x 1638 |

# 4 STANDARD CONFORMITY

The ELIIXA+ cameras have been tested using the following equipment:

- A shielded power supply cable
- A Camera Link data transfer cable ref. 14B26-SZLB-500-OLC(3M)

e2v recommends using the same configuration to ensure the compliance with the following standards.

## *4.1 CE Conformity*

The ELIIXA+ cameras comply with the requirements of the EMC (European) directive 2004/108/CE (EN50081-2, EN 61000-6-2).

## *4.2 FCC Conformity*

The ELIIXA+ cameras further comply with Part 15 of the FCC rules, which states that:
Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation

This equipment has been tested and found to comply with the limits for Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the
instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**Warning**: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

## *4.3 RoHs Conformity*

ELIIXA+ cameras comply with the requirements of the RoHS directive 2002/95/EC.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# EU Declaration of Conformity

**Declaration Number: NE31S208701**

**We,**

**e2v semiconductors**
**rue de Rochepleine**
**38120 Saint-Egrève**
**France**

**declare the product(s)**

Product Family: ***EliiXA+ 16k Cameras***

Model Identification: **EV71YC4MCL1605-Bxx / EV71YC4MCP1605-Bxx**
x = 0-9-A-Z

**in conformance with the requirements of the following standards:**

EN55022 : ed. 2006, A class

EN61000-6-2 : ed. 2005
- IEC 61000-4-2 : ed.2009
- IEC 61000-4-3 : ed.2006 + A1/2008 +A2/2011
- IEC 61000-4-4 : ed.2004
- IEC 61000-4-5 : ed.2006
- IEC 61000-4-6 : ed.2009
- IEC 61000-4-11 : ed.2004

when used in conformity with the recommended set-up (as per the Product Specification or Data Sheet).

**applicable to:** **Information Technology Equipments (I.T.E.)**

**This (These) product(s) complies(y) with the requirements of the:**
- Electromagnetic Compatibility Directive 2004/108/EC,
- CE Marking European Directive 93/68/EEC

**and carry the CE marking accordingly.**

Saint-Egrève, France, on August 23rd, 2012

Martine WOOLF,
Quality Manager

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# 5 GETTING STARTED

## 5.1 Out of the box

The contains of the Camera box is the following :

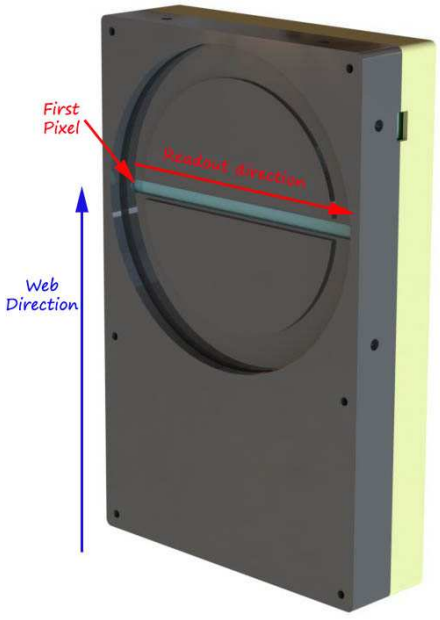
- One Camera ELIIXA+
- Power connector (Hirose HR10A-7P-6S -female)

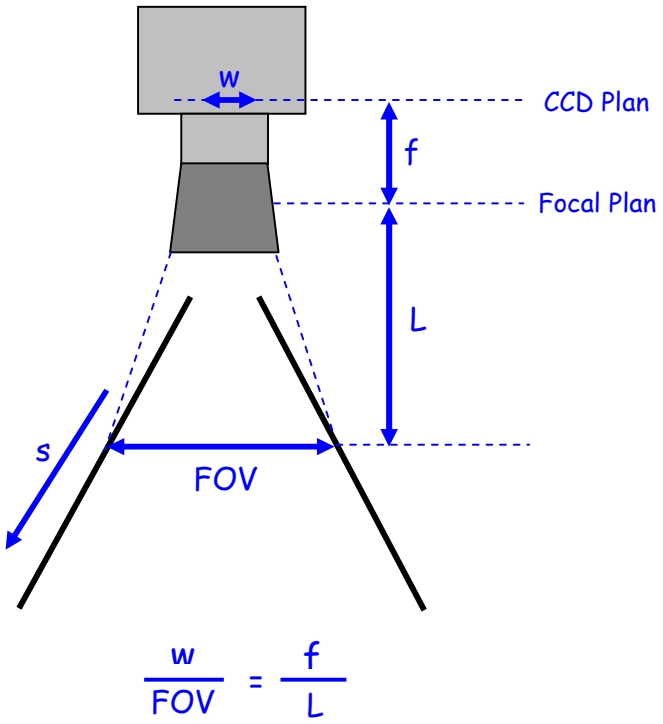
*There is no CDROM delivered with the Camera : Both User Manual (this document) and CommCam control software have to be downloaded from the web site : This ensure you to have an up-to-date version.*

*Main Camera page :* ***www.e2v.com/cameras***
*On the appropriate Camera Page (ELIIXA+) you'll find a download link*
*first version of CommCam compliant is indicated in the last Chapter*
*CommCam download requires a login/password :*

- *Login :* ***commcam***
- *Password :* ***chartreuse***

## 5.2 Setting up in the system



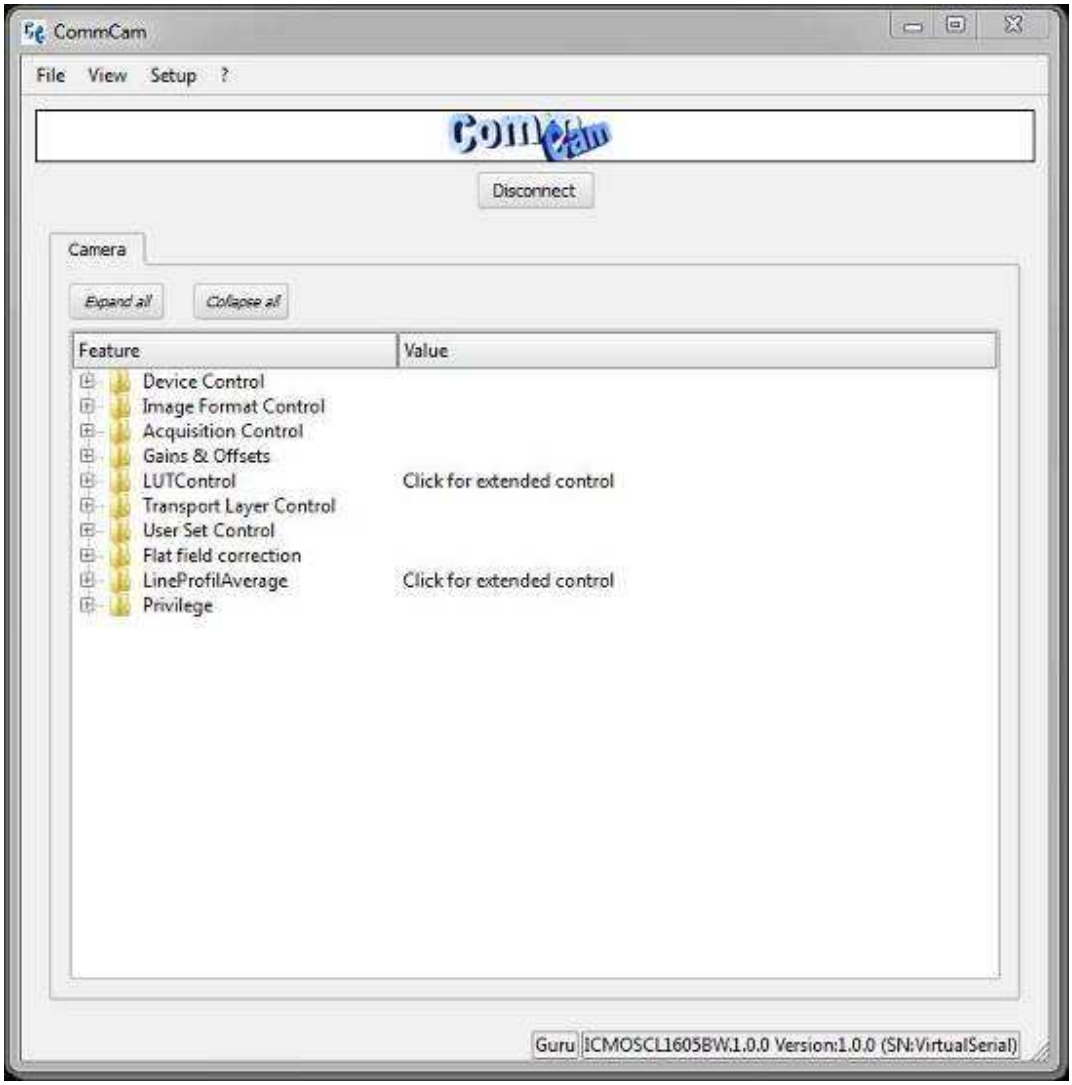




The Compliant Lenses and their accessories are detailed in Appendix C

# 6 CAMERA SOFTWARE INTERFACE

## 6.1 Control and Interface

As all the e2v Cameras, the ELIIXA+ CL is delivered with the friendly interface control software COMMCAM.UCL (as "Ultimate Camera Link") which is based on the GenICam standard
COMMCAM recognizes and detects automatically all the UCL Cameras connected on any transport layers (Camera Link or COM ports) of your system.
Once connected to the Camera you have an easy access to all its features. The visibility of these features can be associated to three types of users: Beginner, Expert or Guru. Then you can make life easy for simple users.
Minimum version of CommCam is 2.1.0 in order to recognize the ELIIXA+ Camera ("BA0" version)



## 6.2 Serial Protocol and Command Format

The Camera Link interface provides two LVDS signal pairs for communication between the camera and the frame grabber. This is an asynchronous serial communication based on RS-232 protocol.
The serial line configuration is:

- Full duplex/without handshaking
- 9600 bauds (default), 8-bit data, no parity bit, 1 stop bit. The baud rate can be set up to 115200

### 6.2.1 Syntax

Internal camera configurations are activated by write or readout commands.
The command syntax for write operation is:

w <command_name> <command_parameters><CR>

The command syntax for readout operation is:

r <command_name><CR>

### 6.2.2 Command Processing

Each command received by the camera is processed:

- The setting is implemented (if valid)
- The camera returns ">"<return code><CR>

The camera return code has to be received before sending a new command.

The camera return code has to be received before sending a new command. Some commands are longer than the others : Waiting for the return code ensure a good treatment of all the commands Without saturating the buffer of the camera

**Table 5-1.** Camera Returned Code

| Returned code | meaning |
|---|---|
| >0 | (or ">OK") : All right, the command will be implemented |
| >3 | Error Bad CRC (for write command only) |
| >16 | Invalid Command ID (Command not recognize or doesn't exist) |
| >33 | Invalid Access (the receipt of the last command has failed). |
| >34 | Parameter out of range (the parameter of the last command send is out of range). |
| >35 | Access Failure (bad communication between two internal devices). |

### 6.2.3 GenICam ready

The CameraLink Standard is not yet compliant with GenICam Standard, but as much as possible, each command of the ELIIXA+ will have its correspondence with the Standard Feature Naming Convention of the GenIcam Standard.
This correspondence is given in parenthesis for each feature/command as the following example :

- **Vendor name** (*DeviceVendorName*) : "**e2v**"

## 6.3 Camera Commands

### 6.3.1 Information

These values allow to indentify the Camera. They can be accessed in CommCam software in the "Info" section

All these values are fixed in factory and can't be changed (shaded) except the Camera User ID which can be fixed by the Customer :

- **Vendor name** (*DeviceVendorName*) : "e2v"
  - ⇨ Read function : "**r vdnm**";
    Returned by the camera : "e2v", string of 32 bytes (including "/0")
  - ⇨ Can not be written

- **Model Name** (*DeviceModelName*) : Internal name for GenICam :
  - ⇨ Read function : "**r mdnm**";
    Returned by the camera : String of 32 bytes (including "/0") :
  - ⇨ Can not be written

- **Device Manufacturer Info** (*DeviceManufacturerInfo*) : Get Camera ID
  - ⇨ Read function : "**r idnb**";
    Returned by the camera : String of 128 bytes (including "/0")
  - ⇨ Can not be written

- **Device Version** (*DeviceVersion*) : Get Camera Hardware version
  - ⇨ Read function : "**r dhwv**";
    Returned by the camera : String of 32 bytes (including "/0")
  - ⇨ Can not be written

- **Device Firmware Version** (*DeviceFirmwareVersion*): Get camera synthetic firmware
  - ⇨ Read function : "**r dfwv**";
    Returned by the camera : String of 16 bytes (including "/0")
  - ⇨ Can not be written

- **Device SFNC Version : 1.5.0**
  These Parameters (Major, Minor, Sub Minor) are only virtual ones in order to give the SFNC compliance of the Camera.

- **Device ID** (*DeviceID*) : Camera Factory identifier ID
  - ⇨ Read function : "**r cust**";
    Returned by the camera : String of 128 bytes (including "/0")
  - ⇨ Write function : "**w cust <idstr>**"

- **Device User ID** (*DeviceUserID*) : Camera user identifier ID
  - ⇨ Read function : "**r cust**";
    Returned by the camera : String of 128 bytes (including "/0")
  - ⇨ Write function : "**w cust <idstr>**"

- **Electronic board ID** (*ElectronicBoardID*) : Get PcB Board ID
  - ⇨ Read function : "**r boid**";
    Returned by the camera : String of 32 bytes (including "/0")
  - ⇨ Can not be written

- **Device Temperature Selector** (*DeviceTemperatureSelector*) : **MainBoard**
  - ⇨ Can not be written

- **Device Temperature** (*DeviceTemperature*) : Get Main Board Temperature
  - ⇨ Read function : "**r temp**";
    Return by the camera : Temperature in Q10.2 format (8 bits signed + 2 bits below comma). Value is between -512 to 511 in °C.

- **Device Serial Port Selection** : Indicates the Serial Port on which the Camera is connected.

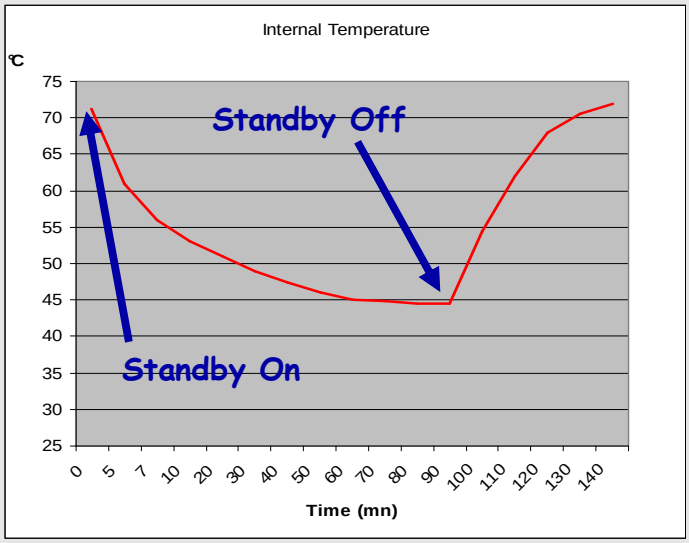
- **Device Serial Port Baud Rate** (*ComBaudRate*): Set the Camera BaudRate
  - ⇨ Read function : "**r baud**";
    Returned by the camera : Value of the Baud Rate
  - ⇨ Write function : "**w baud**" <index> with the index as follows :
    - 1 : 9600 Bauds (default value at power up)
    - 2 : 19200Bauds
    - 6 : 57600Bauds
    - 12 : 115200Bauds

- **Standby Mode** (*Standby*) : Activation of the Standby mode of the Camera
  - ⇨ Read function : "**r stby**";
    Returned by the camera : Boolean.
    - 0 : Disable Standby mode (False)
    - 1 : Enable stanby mode (True)
  - ⇨ Write function : "**w stby <val>**"; <val> is 0 or 1.

**A standby mode, what for ?**

The Standby mode stops all activity on the sensor level. The power dissipation drops down to about **6W**. During the standby mode, **the grab is stopped**

Once the Standby mode turned off, the Camera recovers in less than **1ms** to send images again from the sensor.

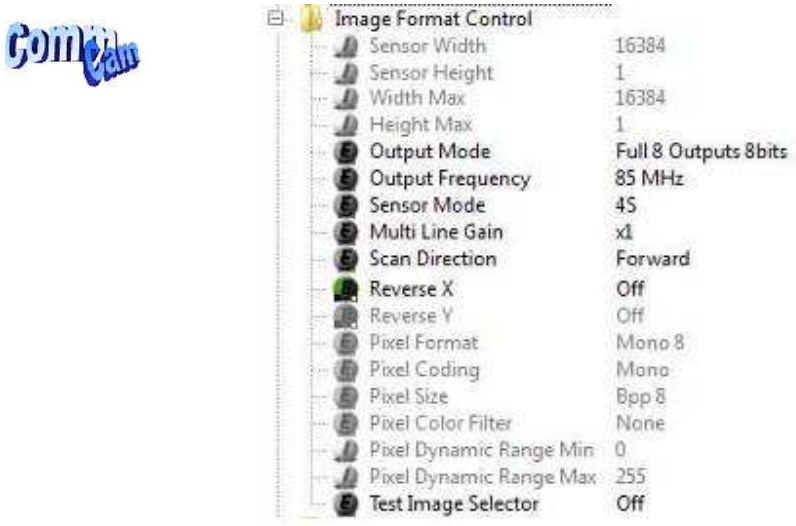



- **Camera status** : Get the Camera status register (32bits Integer)
  - ⇨ Read function : "**r stat**";
    Returned by the camera : 32bits integer :

Status
Error on hardware 0
Status warning FFC or balance underflow 0
Status warning FFC or balance overflow 0
Status scrolling direction. Reverse
Status Sensor Pattern 0

  - **Bit 0** : (*StatusWaitForTrigger*) : True if no trig received from more than 1sec
  - **Bit 1** : (*StatusTriggerTooFast*) : Missing triggers. Trig signal too fast
  - **Bit 2** : (*StatusSensorConnection*) : True is the Sensor pattern is checked as failed.
  - Bit 3, 4, 5, 6, 7 : Reserved
  - **Bit 8** : (*StatusWarningOverflow*) : True is an overflow occurs during FFC or Tap balance processing.
  - **Bit 9** : (*StatusWarningUnderflow*) : True is an underflow occurs during FFC or Tap balance processing
  - Bits 10 : Reserved
  - **Bits 11** : Scrolling Direction : 0 = Forward, 1 = Reverse. Updated only by external CC3 (CameraLink)
  - Bits, 12, 13, 14, 15 : Reserved
  - **Bit 16** : (*StatusErrorHardware*) : True if hardware error detected
  - Bits 17 to 31 : Reserved

## 6.3.2 Image Format



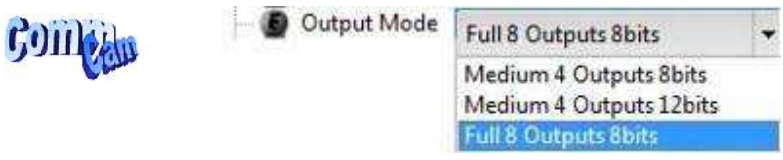

- **Sensor Width** (*SensorWidth*) : Get the physical width of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r snsw**";
    Return by the sensor : Integer 16384.
  - ⇨ Can not be written;

- **Sensor Height** (*SensorHeight*) : Get the physical height of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. Virtual command in xml"; Value always = 1

- **Width Max** (*WidthMax*) : Get the Maximum Width of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. The value is mapped on "SensorWidth"

- **Height Max** (*HeigthMax*) : Get the Maximum height of the Sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ No Access. Virtual command in xml"; Value always = 1

- **Output mode** (*OutputMode*) : Set the CameraLink Output mode (refer also to Chap 3. : CameraLink Output Configuration). This command is available in the CommCam "Image Format Control" section :



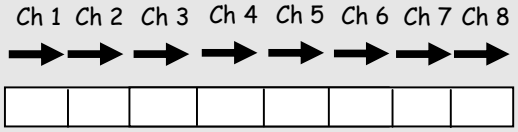
⇨ Read function : "**r mode**";
Returned by the camera : Output mode from 0 to 3 (see table below).
⇨ Write function : **"w mode"** <value> :
detailed in the table below :

| Modes | Connector CL1 | Mode value |
|---|---|---|
| Medium 4 Outputs 8bits | 4 x 85MHz 8 bits | 0 |
| Medium 4 Outputs 12bits | 4 x 85MHz 12 bits | 1 |
| Full 8 Outputs 8bits | 8 x 85MHz 8 bits | 2 |
| Full+ 10 Outputs 8bits (*) | 10 x 85MHz 8 bits | 3 |

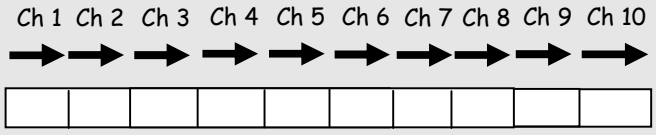
**Structure of the Camera Link Channels for interfacing**

- **Medium Mode 4x4096 Pixels at 85MHz each Channel (4x2048 pixels in Binning Mode 1SB or 2SB)**
  4 Taps Separate, from Left to Right

- **FULL Mode 8x2048 Pixels at 85MHz each Channel (8x1024 pixels in Binning Mode 1SB or 2SB)**
  8 Taps Separate, from Left to Right




- **FULL+ Mode 10x1638 Pixels at 85MHz each Channel (10x819 pixels in Binning Mode 1SB or 2SB)**
  10 Taps Separate, from Left to Right : (*) Not available for EV71YC4MCL1605-**BA0** versions



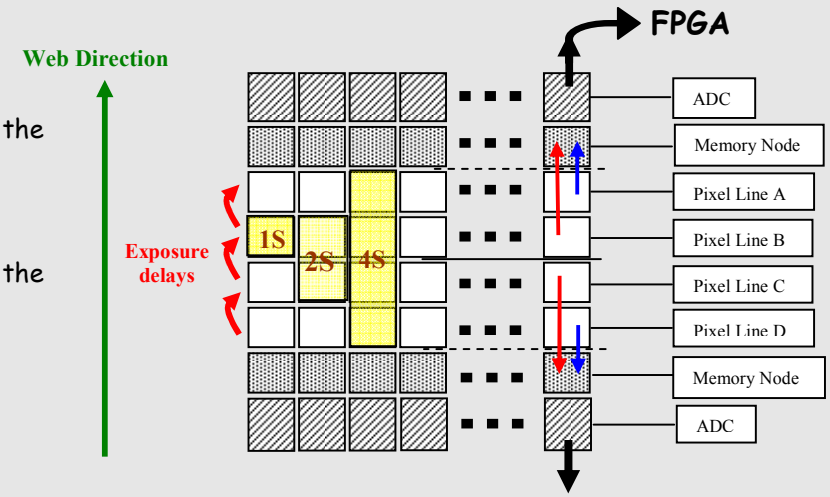

- **Output Frequency** (*OutputFrequency*) : Get the CameraLink Data Output Frequency. This value is available in the CommCam "Image Format Control" section :
  ⇨ Read function : "**r clfq**";
  Return by the Camera : 0 (Frequency = 85MHz)
  ⇨ Can not be written;

- **Sensor Mode** (*SensorMode*) : Defines the number of Line used on the Sensor. This command is available in the CommCam "Image Format Control" section :

**Structure of the Sensor**

In 2S Mode, the summation of the two lines is done in the FPGA :
**B+C**

In 4S Mode, the summation of the two double lines is done in the FPGA :
**(AB )+ (BC)**




⇨ Read function : "**r smod**";
Returned by the camera : Integer from 0 to 4 (0 to 2 for BA0 version)

⇨ Write function : "**w smod**" <value> :

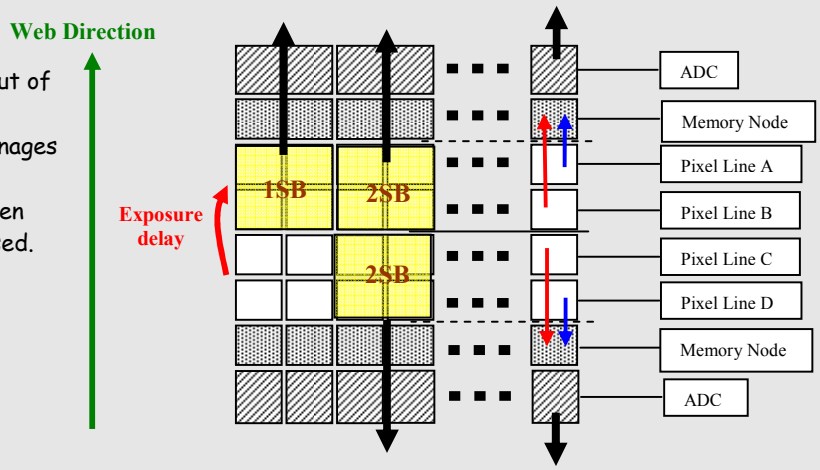
- "0" : "1S" mode or Single Line. Only one line (Line B) of the sensor is outputted.
- "1" : "2S" mode or Dual Lines. The two centred Lines B & C of the sensor are outputted. The Summation is done in the FPGA
- "2" : "4S" mode or Four Lines. All the lines of the sensor are outputted. A & B and B & C summation is done in the sensor. The overall summation is done in the FPGA

Only available with the EV71YC4MCL1605-**BA1** version :

- "3" : "1SB" mode : Binning mode (2x2) which outputs on line of 8k pixels in 10µmx10µm. The summation of the pixels is done in the sensor
- "4" : "2SB" mode : Binning mode 2 x (2x2) which outputs 2 lines of 8k pixels in 10µmx10µm. The summation of the pixels of each line is done in the sensor. The summation of the two lines is done in the FPGA. The appropriate delay for the exposure between the two lines of 8k pixels is managed automatically by the Sensor.

## Binning modes (only available with EV71YC4MCL1605-**BA1** versions)

The two binning modes give an output of 8k pixels 10x10µm.
As for the 2S mode, the sensor manages the delay between the exposure necessary for a good acquisition when the double binning (2SB) mode is used.

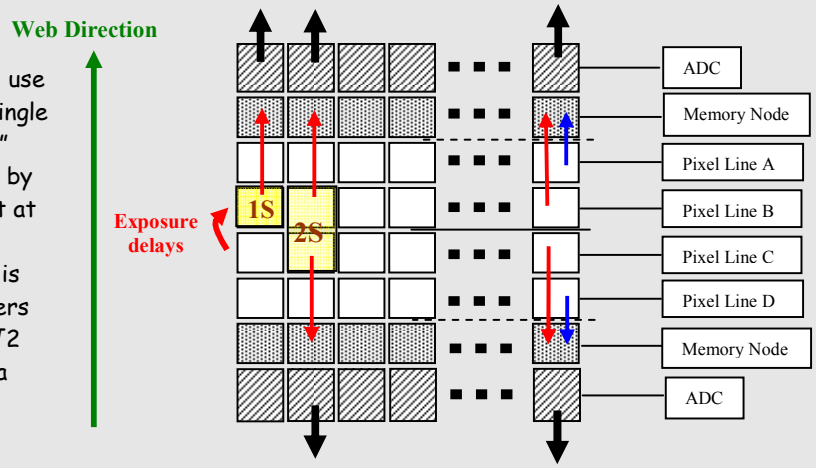



*As the « 4S » mode is performing an internal Time delay exposure on the lines A & B and C & D, the variation of the Exposure time is not possible in this mode. Then the only Two trigger modes available are "Free Run or External Triggered with Maximum Exposure time".*
*Then the parameters "Sensor Mode" and "Synchronization Mode" are linked : If "4S" Sensor mode is selected, only the two synchro modes detailed above are available in the Synchronization mode Menu. In the Same Way, if any of the other Synchronization modes is selected ("Free Run" for example), then the "4S" mode is not available in the Sensor Mode Menu.*

- **Multi-Line Gain** (*MultiLineGain*) : Enables the MultiLine Gain of x0,5 . This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r mlig**";
    Return by the sensor : "0" if disabled (Gain x1 by default); "1" if Gain x0,5 activated.
  - ⇨ Write Function : "**w mlig** <value>"
    - "0" : Default Gain x1 is active.
    - "1" : Gain x0,5 is enabled (only when the 2S mode of the sensor is enabled)

## Why Using a Multi-Line Gain of x0,5 ?

When the Light source is enough to use the "1S" mode of the Sensor (one single line), the best is to use 2 lines ("2S" mode) and then to divide the result by two by using the Multi-Line Gain set at "x0,5" :
In this case, the Full Well capacity is multiplied by x2 (two output registers are used) but the noise divided by √2 therefore the SNR is improved by a factor of √2.



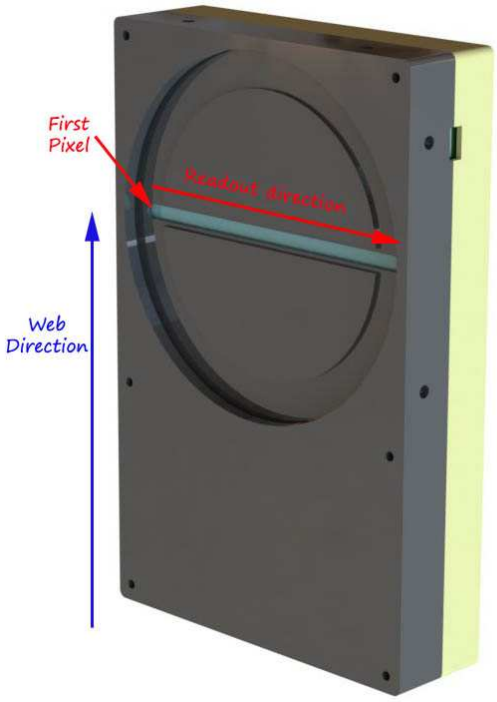

- **Reverse Reading (X)** (*ReverseReading*) : Allows to output the line in the Reverse-X direction. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r revr**";
    Return by the Camera : 0 or 1 (enabled/disabled)
  - ⇨ Write function : "**w revr** <value>";
    - "0" : Disabled.
    - "1" : Enables the reverse reading out (see below for "normal" direction)

- **Scan Direction** (*ScanDirection*) : Set the scan direction for the sensor. This value is available in the CommCam "Image Format Control" section :
  - ⇨ Read function : "**r scdi**";
    Return by the Camera : 0, 1 or 2 (Forward/reverse/external)

  - ⇨ Write function : "**w scdi** <value>";
    - "0" : Forward.
    - "1" : Reverse
    - "2" : Externally controlled (by CC3 of the CameraLink Sync signals)

  Forward/reverse information has to be set correctly as soon as the Mode "2S" or "4S" of the sensor is set : In these tow modes, the sensor/Camera need to know what is the real order of the lines for the exposure delays.

The Forward direction is defined as detailed beside :




**Note** : The delay for the Camera to take in account a change in the ScanDirection value is :

- In 2S mode : **1s**
- In 4S mode : **1,5s**

This information can be set dynamically by using the CC3 Trig signal of the CameraLink connector (change the direction "on the fly").
In these case, the Trigger signification is :

- "0" : Forward.
- "1" : Reverse

This positioning takes also in account that the mode "Reverse X" is "Off" (Normal readout direction)

- **Test Image Selector** (*TestImageSelector*) : Defines if the data comes from the Sensor or the FPGA (test Pattern). This command is available in the CommCam "Image Format" section :

⇨ Read function : "**r srce**";
Returned by the camera : "0" if Source from the Sensor and "1 to 5" if test pattern active

⇨ Write function : "**w srce**" <value> :

- "0" : To switch to CCD sensor image
- "1" : Grey Horizontal Ramp (Fixed) : **See AppendixA**
- "2" : White Pattern (Uniform white image : 255 in 8Bits or 4095 in 12bits)
- "3" : Grey Pattern (Uniform middle Grey : 128 in 8bits or 2048 in 12 bits)
- "4" : Black Pattern (Uniform black : 0 in both 8 and 12 bits)
- "5" : Grey vertical Ramp (moving)

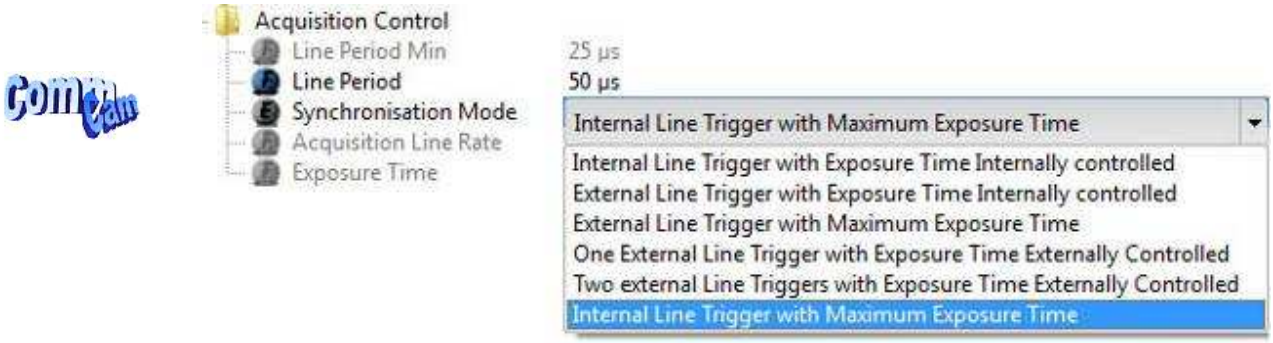
The test pattern is generated in the FPGA : It's used to point out any interface problem with the Frame Grabber.
When any of the Test pattern is enabled, the whole processing chain of the FPGA is disabled.

### 6.3.3 Acquisition Control

This section deals with all the Exposure, Line period and synchronisation modes

Acquisition Control
Line Period Min 10 µs
Line Period 25 µs
Synchronisation Mode Free run
Acquisition Line Rate 400000 Hz
Exposure Time 25 us

- **Synchronisation Mode** (TriggerPreset) : Timed or Triggered, it defines how the grabbing is synchronized. This command is available in the CommCam "Acquisition Control" section :

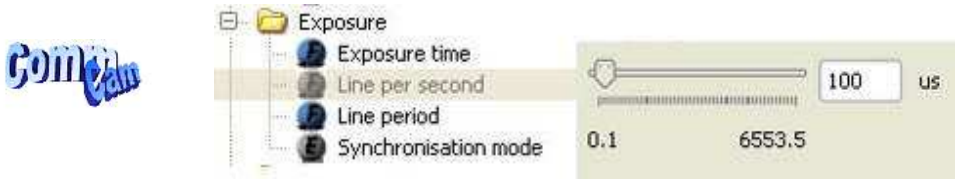

Acquisition Control
Line Period Min
Line Period
Synchronisation Mode
Acquisition Line Rate
Exposure Time
25 µs
50 µs
Internal Line Trigger with Maximum Exposure Time
Internal Line Trigger with Exposure Time Internally controlled
External Line Trigger with Exposure Time Internally controlled
External Line Trigger with Maximum Exposure Time
One External Line Trigger with Exposure Time Externally Controlled
Two external Line Triggers with Exposure Time Externally Controlled
Internal Line Trigger with Maximum Exposure Time

⇨ Read function : "**r sync**";
Returned by the camera :
- "**0**" : Internal Line Trigger with Exposure time Internally Controlled (Free Run). Not available when Sensor mode is set in "4S"
- "**1**" : External Trigger with Exposure Time Internally Controlled. Not available when Sensor mode is set in "4S"
- "**2**" : External Trigger with maximum Exposure time
- "**3**" : One External with Exposure Time Externally Controlled. The same Trigger signal defines the line period and its low level defines the exposure time. Not available when Sensor mode is set in "4S"
- "**4**" : Two External Triggers with Exposure Time Externally Controlled : CC2 defines the start of the exposure (and also the start Line) and CC1 defines the Stop of the exposure. Not available when Sensor mode is set in "4S"
- "**5**" : Internal Line Trigger with maximum Exposure Time

⇨ Write function : "**w sync**" <value>

*The Timing diagrams associated to each Synchronization mode and the Timing values associated are detailed in the APPENDIX B of this document.*

- **Exposure time** (*ExposureTime*): Defines the exposure time when set in the Camera. This command is available in the CommCam "Acquisition Control" section :



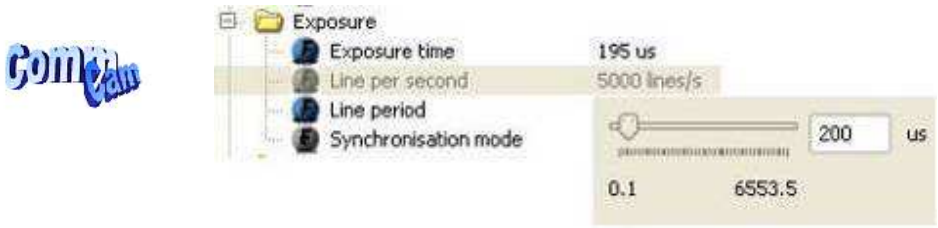

⇨ Read function : "**r tint**";
Returned by the camera : Integer from 15 to 65535 (=1,5µs to 6553,5µs by step o 0,1µs)
⇨ Write function : "**w tint**" <value> ;

This value of exposure time is taken in account only when the synchronisation mode is "free run" (0) or "Ext Trig with Exposure time set" (1). Otherwise it's ignored.

Due to the limitation of the timing pixel inside the sensor, the Exposure time has to be set by taking in account the limitation detailed in the APPENDIX B of this document.
The **Minimum exposure time** which can be set is :

- **4,2µs** with the EV71YC4MCL1605-BA0 version
- **1,5µs** with the EV71YC4MCL1605-BA1 version

- **Line Period** (*LinePeriod*) : Defines the Line Period of the Camera in Timed mode. This command is available in the CommCam "Acquisition Control" section :



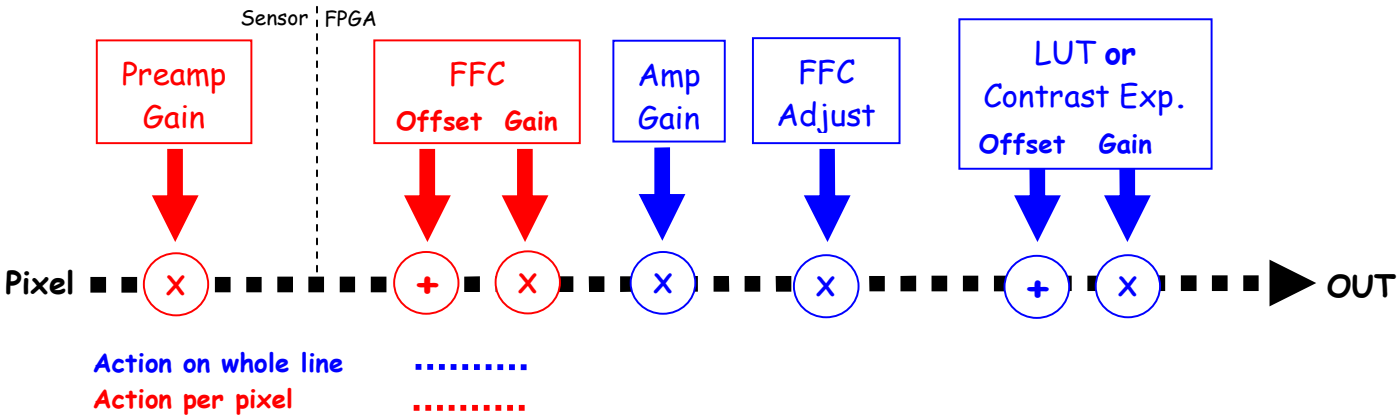

⇨ Read function : "**r tper**";
Returned by the camera : Integer from 1 to 65536 (=0,1µs to 6553,6µs by step o 100ns)
⇨ Write function : "**w tper**" <value> ;

The line period is active only in Free Run modes. It's also disabled if in this mode, the Integration time is set higher than the Line Period.

*Minimum Line Period*

Medium modes (4 Taps) : **50µs**
Full Mode (8 Taps) : **25µs**
Full+ Mode (10 Taps) : **20µs** (not available with EV71YC4MCL1605-**BA0** version)

## 6.3.4 Gain and Offset

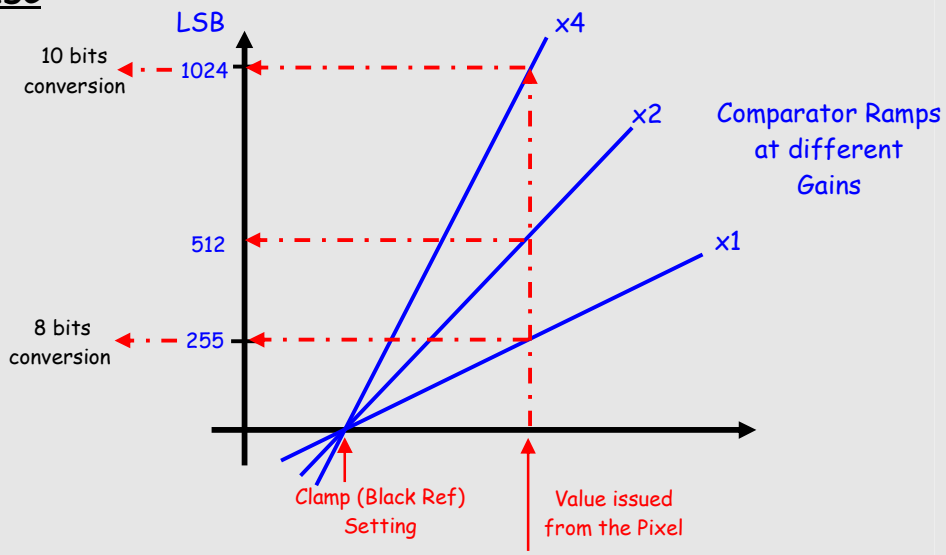



### Analog Gain in the ADC

The only analog Gain available in the ELIIXA+ is located at the sensor level, in the ADC converter.

This "Preamp Gain" is in fact a variation of the ramp of the comparator of the ADC.

Then 3 Values are available :
x1, x2 and x4

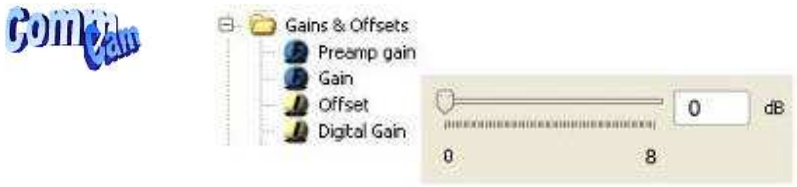



- **Preamp Gain** : (*GainAbs* with *GainSelector*= *AnalogAll*)
  Set the Pre-amplification Gain. This command is available in the CommCam "Gain & Offset" section.

  ⇨ Read function : "**r pamp**";
  Returned by the camera : Integer corresponding to one of the 3 different step values :
  - 0 : x1 (0dB)
  - 1 : x2 (6dB)
  - 2 : x4 (12dB)

  ⇨ Write function : "**w pamp**" <int> ;

- **Gain:** (*GainAbs* with *GainSelector*= *GainAll*)
  Set the Amplification Gain. This command is available in the CommCam "Gain & Offset" section :

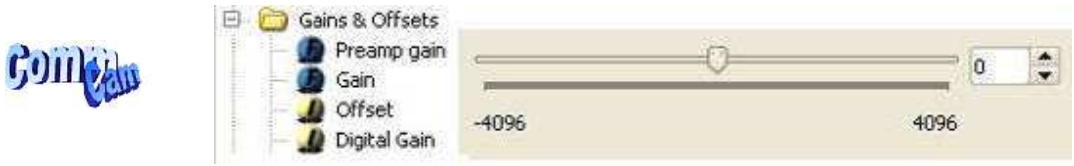



  ⇨ Read function : "**r gain**";
  Returned by the camera : Value from 0 to 6193 corresponding to a Gain range of 0dB to +8dB calculated as following : Gain(dB) = 20.log(1+ Gain/4096).
  ⇨ Write function : "**w gain**" <int> ;

- **Digital Gain** (*GainAbs* with *GainSelector*=*DigitalAll*) : Set the global Digital Gain. This command is available in the CommCam "Gain & Offset" section :

  ⇨ Read function : "**r gdig**";
  Returned by the camera : Integer value from 0 to 255. The corresponding Gain is calculated as 20log(1+val/64) in dB
  ⇨ Write function : "**w gdig**" <int> ;

- **Digital Offset** (*BlackLevelRaw* with *BlackLevelSelector*=*All*) : Set the global Digital Offset. This command is available in the CommCam "Gain & Offset" section :




  ⇨ Read function : "**r offs**";
  Returned by the camera : Value from –4096 to +4095 in LSB
  ⇨ Write function : "**w offs**" <int> ;

*The Contrast Expansion (both Digital Gain & Offset) will be automatically disabled if the LUT is enabled..*

## 6.3.5 Flat Field Correction

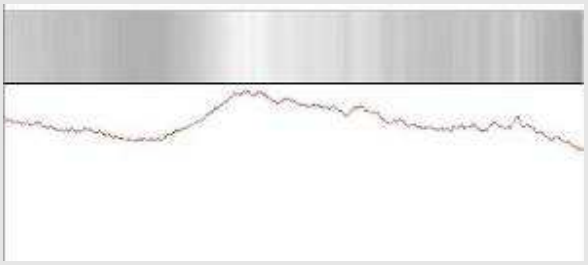
### How is performed the Flat Field Correction ?

***What is the Flat Field correction (FFC) ?***

The Flat Field Correction is a digital correction on each pixel which allows :

- To correct the Pixel PRNU (Pixel Response Non Uniformity) and DSNU (Dark Signal Non Uniformity)
- To Correct the shading due to the lens
- To correct the Light source non uniformity

**Before**



**After**

***How is calculated / Applied the FFC ?***

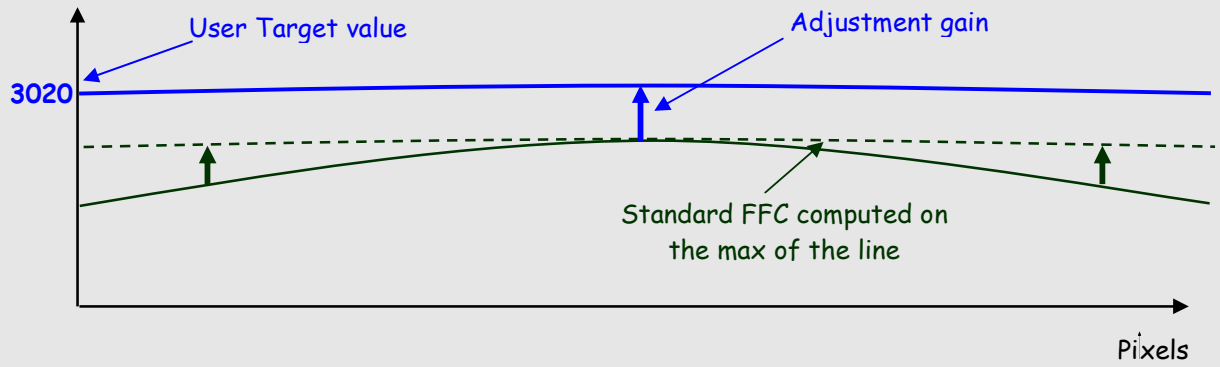
The FFC is a digital correction on the pixel level for both Gain and Offset.

- Each Pixel is corrected with :
  - An Offset on 8 bits (Signed Int 5.3). They cover a dynamic of ±16LSB in 12bits with a resolution of 1/8 LSB 12bits.
  - A Gain on 14 bits (Unsigned Int 14) with a max gain value of x3
  - The calculation of the new pixel value is : **P' = ( P + Off).(1 + Gain/8192)**

The FFC processing can be completed with an automatic adjustment to a global target. This function is designed as "**FFC Adjust**". This adjustment to a User target is done by an internal hidden gain which is re-calculated each time the FFC is processed while the FFC adjust function is enabled.

The FFC is always processed with the max pixel value of the line as reference. If enabled, the FFC adjust module (located at the output of the FFC module) calculates the adjustment gain to reach the target defined by the User.

When the FFC result is saved in memory, the adjust gain and target are saved in the same time in order to associate this gain value with the FFC result.




***How to perform the Flat Field Correction ?***

**FPN/DSNU Calibration**

- Cover the lens
- Launch the FPN Calibration : Grab and calculation is performed in few seconds

**PRNU Calibration**

The User must propose a white/gray uniform target to the Camera (not a fixed paper).
The Gain/Light conditions must give a non saturated image in any Line.
The Camera must be set in the final conditions of Light/ Gain and in the final position in the System.
I f required, set a user target for the FFC adjust and enable it.

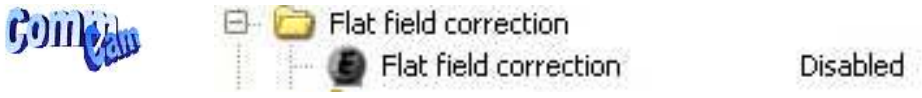
- White uniform (moving) target
- Launch the FFC
- Enable the FFC
- You can save the FFC result (both FPN+PRNU in the same time) in one of the 4 x FFC User Banks.
- The user target and Gain are saved with the associated FFC in the same memory.

**Advices**

The ELIIXA+ Cameras have 4 x FFC Banks to save 4 x different FFC calibrations. You can use this feature if your system needs some different conditions of lightning and/or Gain because of the inspection of different objects : You can perform one FFC per condition of Gain/setting of the Camera ( 4 Max) and recall one of the four global settings (Camera Configuration + FFC + Line Balance) when required.

#### 6.3.5.1 Activation and Auto-Adjust

- **FFC Activation** (*FFCEnable*) : Enable/disable the Flat Field Correction. This command is available in the CommCam "Flat Field Correction" section :




  - ⇨ Read function : "**r ffcp**" : Returns the FFC Status (0 if disabled, 1 if enabled)
  - ⇨ Write function :
    - "**w ffcp 1**" : Enable the FFC.
    - "**w ffcp 0**" : Disabled the FFC

- **FFC Adjust Function** : This Feature is available in the CommCam "Flat Field Correction/ Automatic Calibration" section :

  - o **Gains adjust** (*FFCAdjust*)**:** Enable/Disable the function
    - ⇨ Read function : "**r ffad**". Returns the status of the function (0 if disabled)
    - ⇨ Write function :
      - "**w ffad 0**" : Disable the FFC Adjust function.
      - "**w ffad 1**" : Enable the FFC Adjust function.

  - o **Auto Adjust Target Level** (*FFCAutoTargetLevel*)**:** set the value for the User Target.
    - ⇨ Read function : "**r tfad**". Returns the Target value (from 0 to 4095)
    - ⇨ Write function : "**w tfad <value>**" : Set the Target Value (in 12bits)
    - ⇨

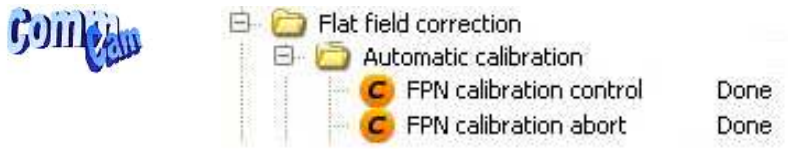
**FFC Adjust : A good usage.**

When there are several Cameras to set up in a system on a single line, the most difficult is to have a uniform lightning whole along the line.
If each Camera performs its own Flat field correction, relative to the max of each pixel line, the result will be a succession of Camera lines at different levels.
=> The FFC Adjust function allows to set the same target value for all the Cameras in the system and then to get a perfect uniform line whole along the system with a precision of 1 LSB to the Target.
The Maximum correction is x2 the highest value of the line.

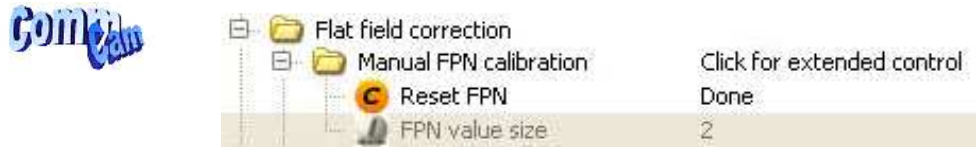
The reasonable value for the User Target is not more than around 20% of the max value of the line.

### 6.3.5.2 Automatic Calibration

- **FPN/DSNU Calibration :**
  - **FPN Calibration Control** (*FPNCalibrationCtrl*) : Launch or abort of the FPN process for the Offsets calculation. These commands are available in the CommCam "Flat Field Correction / Automatic Calibration " section :

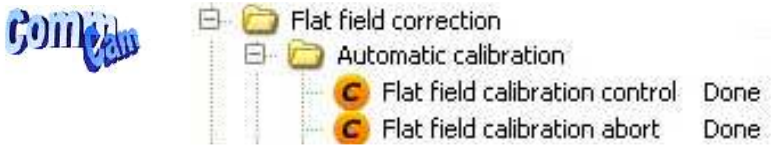



    - ⇨ Read function : "**r calo**" : Returns the FPN Calculation Process Status (0 if finished, 1 if processing)
    - ⇨ Write function :
      - "**w calo 1**" : Launch the FPN Calibration Process.
      - "**w calo 0**" : Abort the FPN Calibration Process.
  - **FPN Coefficient Reset** (*FPNReset*) : Reset the FPN (Offsets) coefficient in Memory. This command is available in the CommCam "Flat Field Correction / Manual Calibration " section :




    - ⇨ Write function : "**w rsto 0**" : Reset (set to 0) the FPN coefficients in memory. This doesn't affect the FFC User Memory Bank but only the active coefficients in Memory.

- **PRNU Calibration :**
  - **PRNU Calibration Control** (*FFCCalibrationCtrl*) : Launch or abort of the PRNU process for the Gains calculation. This command is available in the CommCam "Flat Field Correction / Automatic Calibration " section :




    - ⇨ Read function : "**r calg**" : Returns the PRNU Calculation Process Status (0 if finished, 1 if processing)
    - ⇨ Write function :
      - "**w calg 1**" : Launch the PRNU Calibration Process.
      - "**w calg 0**" : Abort the PRNU Calibration Process.
  - **PRNU coefficient Reset** (*PRNUReset*) : Reset the PRNU (Gains) coefficient in Memory. This command is available in the CommCam "Flat Field Correction / Manual Calibration " section :

⇨ Write function : "**w rstg 0**" : Reset (set to "x1") the PRNU coefficients in memory. This doesn't affect the FFC User Memory Bank but only the active coefficients in Memory.

Some Warnings can be issued from the PRNU/FPN Calibration Process as "pixel Overflow" of "Pixel Underflow" because some pixels have been detected as too high or too low in the source image to be corrected efficiently.
The Calculation result will be proposed anyway as it's just a warning message.
The Status Register is the changed and displayed in CommCam "Status" section :

Register status is detailed chap §6.3.3.

### 6.3.5.3 Manual Flat Field Correction

The FFC Coefficients can also be processed outside of the Camera or changed manually by accessing directly their values in the Camera : This is the "Manual" FFC.

In CommCam, the User can access to a specific interface by clicking on "click for extended control" in both "Manual FFC calibration" and "Manual FPN calibration sections" :

This will allow the user to upload/download out/in the Camera the FFC coefficients in/from a binary or text file that can be processed externally.

It is recommended to setup the baud rate at the maximum value possible (115000 for example) otherwise the transfer can take a long time.

- **FPN coefficients modification :** Direct access to the FPN coefficients for reading or writing. The FPN coefficients are read packets of x128 coefficients :

  ⇨ Read function : "**r ffco <addr>**" : Read 128 consecutive FPN user coefficients starting from **<addr>** address. Returned value is in hexadecimal, without space between values (one unsigned short per coefficient).
  ⇨ Write function :" **w ffco <addr><val>** : Write 128 consecutive FPN user coefficients starting from the **<addr>** address. **<val>** is the concatenation of individual FPN values, without space between the values (one unsigned short per coefficient).

- **PRNU coefficients modification :** Direct access to the PRNU coefficients for reading or writing. The PRNU coefficients are read packets of x128 coefficients :

  ⇨ Read function : "**r ffcg <addr>**" : Read 128 consecutive PRNU user coefficients starting from **<addr>** address. Returned value is in hexadecimal, without space between values (one unsigned short per coefficient).
  ⇨ Write function :" **w ffcg <addr><val>** : Write 128 consecutive PRNU user coefficients starting from the **<addr>** address. **<val>** is the concatenation of individual PRNU values, without space between the values (one unsigned short per coefficient).

#### 6.3.5.4 FFC User Bank Management

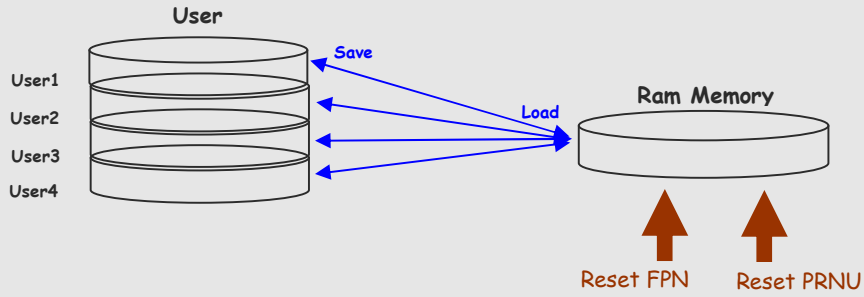
The new-processed FFC values can be saved or restored in/from 4 x User banks.
Both Gains and Offsets in the same time but also the FFC Adjust User target and associated gain.
These functions are available in the Flat Field correction/Save & Restore FFC section :

- **Restore FFC from Bank** (*RestoreFFCFromBank*) : Restore the FFC from a Bank in the current FFC.
  ⇨ Read function : "**r rffc**" : Get the current FFC Bank used
  Returned by the camera : 0 for Factory bank or 1 to 4 for User banks
  ⇨ Write function : "**w rffc <val>**" : Bank <val> 1 to 4 for User banks

  Note : Factory means neutral FFC (no correction).

- **Save FFC in User Bank** (*SaveFFCToBank*) : Save current FFC in User Bank
  ⇨ Can not de read
  ⇨ Write function : "**w sffc <val>**" : User bank <val> if from 1 to 4.

## FFC User Bank Usage




**At the power up :**
- Last User Bank used is loaded in RAM

**Reset a User bank :**
- Reset the RAM (FPN/PRNU individually)
- Save in the bank to reset

### 6.3.6 Look Up Table

The User can define an upload a LUT in the Camera that can be used at the end of the processing.
The LUT is defined as a correspondence between each of the 4096 gray levels (in 12 bits) with another outputted value. For example, a "negative" or "reverse" LUT is the following equivalence :

| Real value | Output value |
|---|---|
| 0 | 4095 |
| 1 | 4094 |
| 2 | 4093 |
| ... | |

Then the size of each value is 12bits but the exchanges with the Application/PC are done on 16 bits :
For 4096 gray levels (from 0 to 4095) the total file size for a LUT is 8Ko.

If this LUT is enables, the "Contrast Expansion" feature (digital Gain and Offset) will be disabled

- **LUT Enable** (*LUTEnable*) : Enable the LUT and sizable the Digital Gain / Offset
  This function is available in the LUT section :.

  ⇨ Read function : "**r lute**" : Get the LUT status
  Returned by the camera : 0 is LUT disabled, 1 if enabled
  ⇨ Write function : "**w lute <val>**" : <val> is 0 for disable, 1 for enable

- **Upload / Download the LUT coefficients :** Direct access to the LUT coefficients for reading or writing. In CommCam, the User can access to a specific interface by clicking on "click for extended control" in the LUT section :

⇨ Read function : "**r lutc <addr>**" : Read 128 LUT coefficients starting from address **<addr>** from 0 to 4095-128. Returned value is the concatenation in hexadecimal of individual LUT values, without space between values. (one unsigned short per coefficient)

⇨ Write function :" **w lutc <addr><val>** : Write 128 LUT coefficients starting from address **<addr>** form 0 to 4095-128. **<val>** is the concatenation in hexadecimal of individual LUT values, without space between values. (one unsigned short per coefficient)

- **Save & Restore LUT in User Banks** : The LUT loaded in RAM memory can be saved or restored in/from 4 User banks.
  These functions are available in the LUT/Save & Restore LUT Settings section :

o **Restore LUT from Bank** (*RestoreLUTFromBank*) : Restore the LUT from a User Bank in the current RAM Memory.

⇨ Read function : "**r rlut**" : Get the current LUT Bank used
Returned by the camera : 1 to 4 for User banks

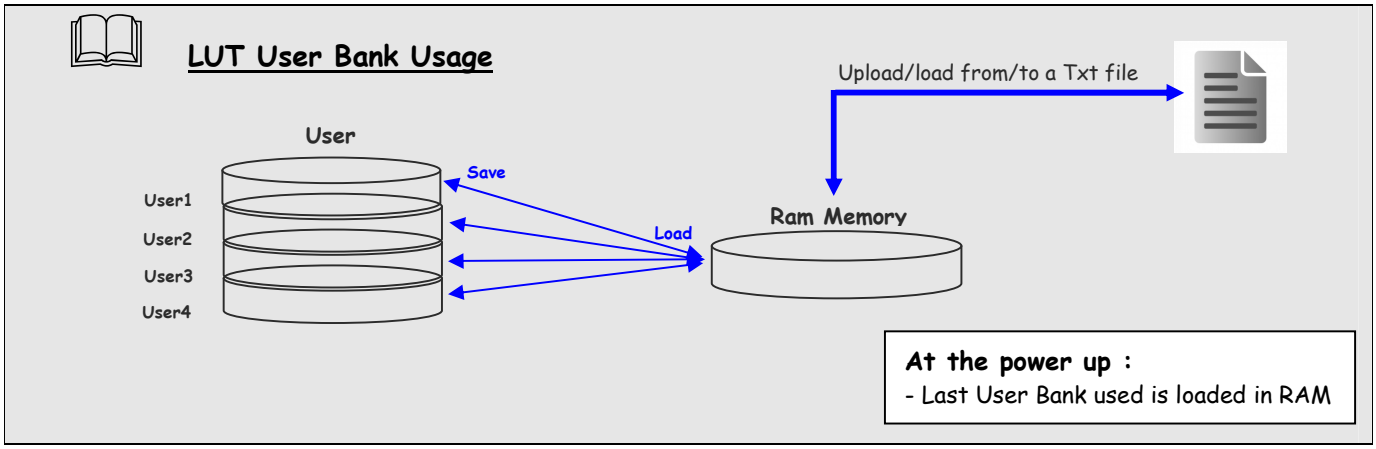
⇨ Write function : "**w rlut <val>**" : Bank <val> 1 to 4 for User banks

o **Save LUT in User Bank** (*SaveLUTToBank*) : Save current LUT in User Bank

⇨ Can not de read

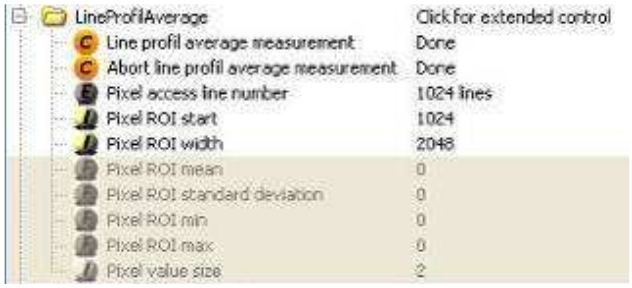
⇨ Write function : "**w slut <val>**" : User bank <val> if from 1 to 4.

The bank number <val> is given in (*LUTSetSelector*)



## 6.3.7 Statistics and Line Profile

This function allows the User to get some statistics on a pre-defined ROI. On request, the Camera acquires and then calculates some key values as the min, the max, the average or the standard deviation in this Region of Interest.
The grab and calculation command and also the collection of the results is not performed in real time as it is done through the serial connection.
This function and the results are available in CommCam in the "Line Profile Average" Section :




- **Line Profile average measurement** (*LineAverageProfile*) : Control the grab and computation of the statistics.
  ⇨ Read function : "**r pixs**" : Get the status of the calculation
  Returned by the camera : 0 : finished, 1: running
  ⇨ Write function :
    - "**w pixs 1**" : Start the accumulation and then the computing
    - "**w pixs 0**" : Abort the computing.

The Calculated values are detailed as following :

- **Pixel average Value** (*PixelROIMean*) : Average gray level value calculated on whole Region of interest
  ⇨ Read function : "**r pavr**" : Get the average value
  Returned by the camera : Unsigned format value : U12.4
- **Pixel Standard deviation** (*PixelROIStandardDeviation*) : standard deviation of all the pixel gray level values of Region of interest
  ⇨ Read function : "**r pstd**" : Get the standard deviation
  Returned by the camera : Unsigned format value : U12.4
- **Pixel Min value** (*PixelROIMin*) : Minimum gray level pixel value on the whole region of interest.
  ⇨ Read function : "**r pmin**" : Get the Minimum value
  Returned by the camera : Unsigned format value : U12.4
- **Pixel Max Value** (*PixelROIMax*) : Maximum gray level pixel value on the whole region of interest
  ⇨ Read function : "**r pmax**" : Get the maximum value
  Returned by the camera : Unsigned format value : U12.4

- **Pixel access Line number** (*PixelAccessLineNumer*) : Set the number of lines to accumulate.
  ⇨ Read function : "**r pixl**" : Get the number of line
  Returned by the camera : 1, 256, 512 or 1024
  ⇨ Write function : "**w pixl <val>**" : Set the number of lines. <val> is 1, 256, 512 or 1024.

- **Pixel ROI Start** (*PixelRoiStart*) : Set the Region of Interest start position.
  ⇨ Read function : "**r prod**" : Get the starting pixel
  Returned by the camera : value between 0 and 16383
  ⇨ Write function : "**w prod <val>**" : Set the starting pixel. <val> is between 0 and 16383

- . **Pixel ROI Width** (*PixelRoiWidth*) : Set the Width of the Region of Interest.
  ⇨ Read function : "**r prow**" : Get the width in pixel
  Returned by the camera : value between 1 and 16384
  ⇨ Write function : "**w prow <val>**" : Set the ROI width in pixels. <val> is between 1 and 16384

After performing a line profile measurement, all the values computed which are described below are not refreshed automatically in CommCam : You have to right-click on each value and ask for an individual refresh.

## 6.3.8 Privilege Level

There are 3 privilege levels for the camera :
- Factory (0) : Reserved for the Factory
- Integrator (1) : Reserved for system integrators
- User (2) : For all Users.

The Cameras are delivered in Integrator mode. They can be locked in User mode and a specific password is required to switch back the Camera in Integrator mode. This password can be generated with a specific tool available from the hotline (hotline-cam@e2v.com)

This function is available in the Privilege section :

- **Privilege level Management** (*PrivilegeLevel*) : Get the current Camera privilege level..
  ⇨ Read function : "**r lock**" : Get the current privilege
  Returned by the camera : 0 to 2
  ⇨ Write function : "**w lock <val>**" : <val> is as follow
    - **2** : Lock the Camera in Integrator or "privilege User"
    - **<computed value>** : Unlock the Camera back in Integrator mode

### 6.3.9 Save & Restore Settings

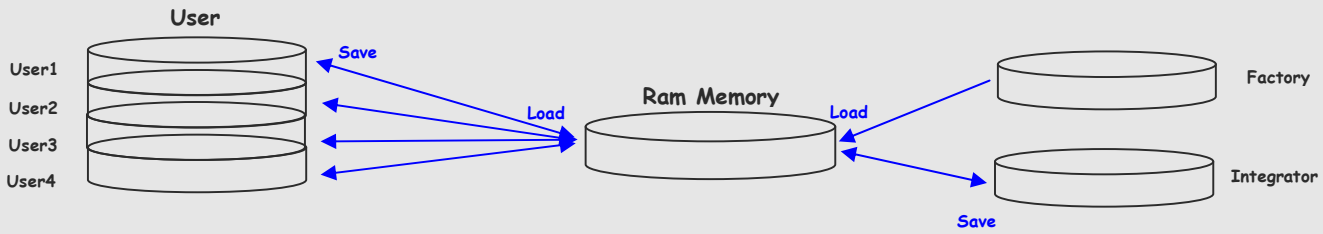
The settings (or Main configuration) of the Camera can be saved in 4 different User banks and one Integrator bank. This setting includes also the FFC and LUT enable
This function is available in the Save & Restore Settings section :

- **Load settings from Bank :** Allows to restore the Camera settings.
  - ⇨ Read function : "**r rcfg**" : Get the current Tap Bank in use
  - ⇨ Write function : "**w rcfg <val>**" : Load settings from bank <val> (0: Factory , 1 to 4 for Users, 5 for Integrator)

- **Save settings to Bank :** Allows to save the Camera settings in User or Integrator Bank
  - ⇨ Write function : "**w scfg <val>**" : Save the current settings in the User bank <val> (1 to 4 for User, 5 for Integrator)

The integrator bank (User Set5) can be written only if the Camera is set in integrator mode (Privilege level = 1). This integrator bank can be used as a « Factory default » by a system integrator.

**Configuration Bank Usage**




**At the power up :** Last User Bank used is loaded in RAM
"Integrator" Bank (5) can be locked by switching the Camera in "User" mode (cf : Privilege feature).
Then it can't be saved any more without switching back the Camera in "Integrator" Mode.

# 7 APPENDIX A: Test Patterns

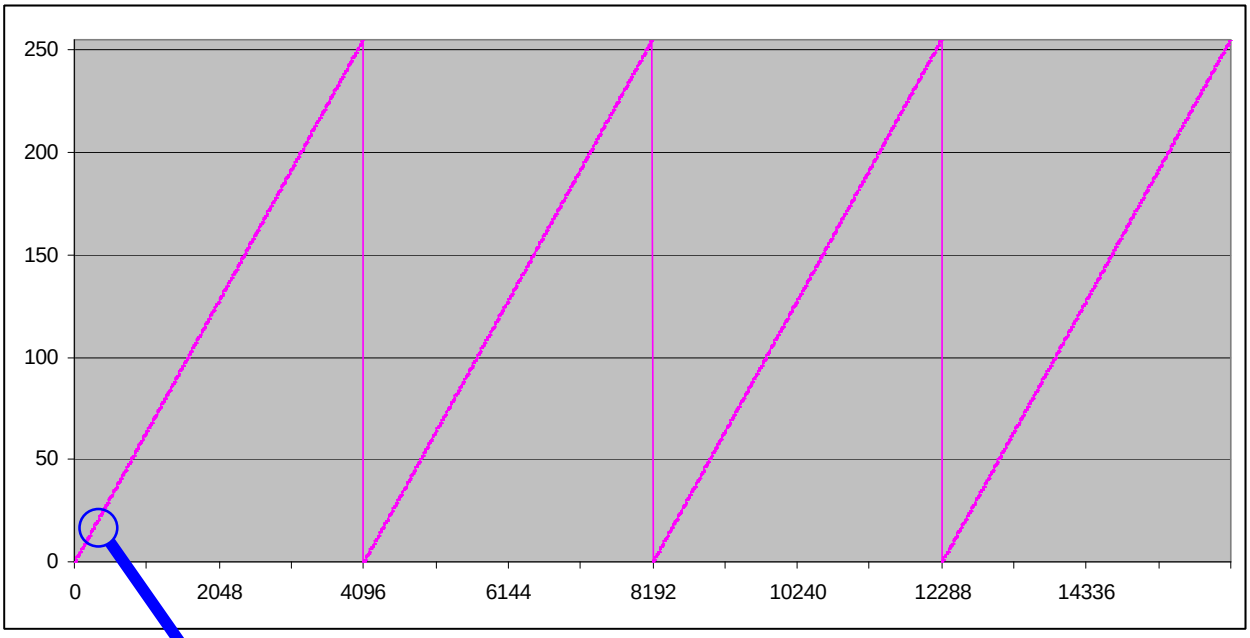
## 7.1 Test Pattern 1: Vertical wave

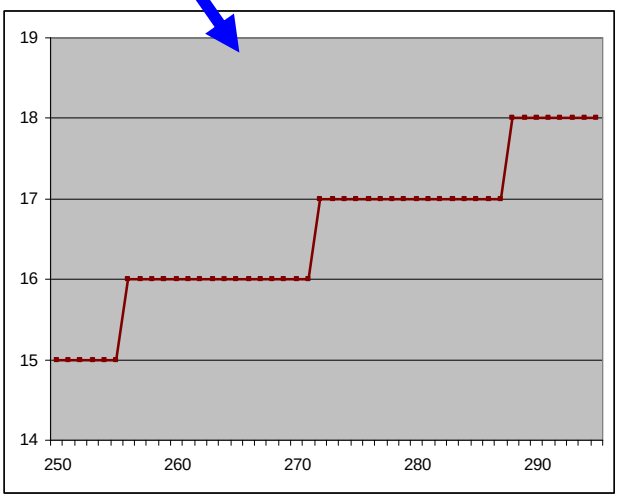
The Test pattern 1 is a vertical moving wave : each new line will increment of 1 gray level in regards with the previous one.

- In 12 bits the level reaches 4095 before switching down to 0
- In 8 bits the level reaches 255 before switching down to 0

## 7.2 Test Pattern 2: Fixed Horizontal Ramps

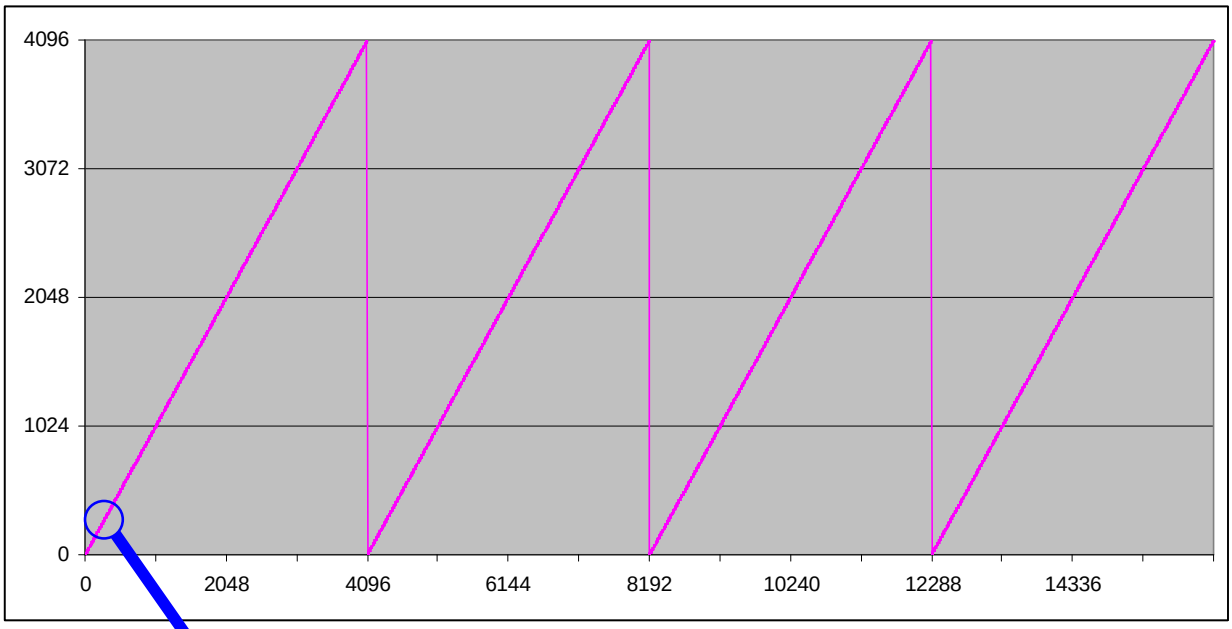
### 7.2.1 In 8 bits (Full) format – No Binning (16384 pixels)

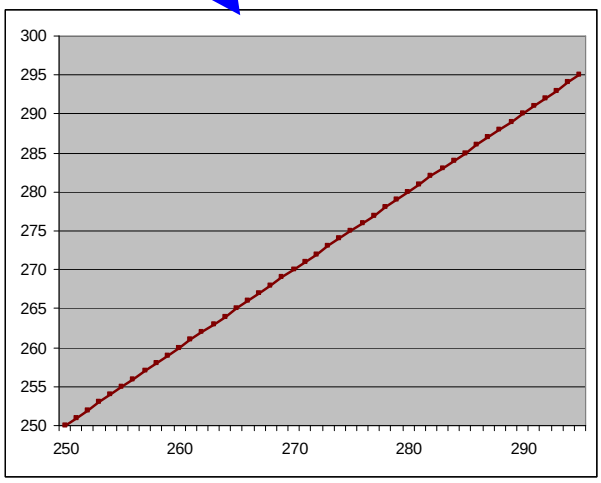



An increment of 1 LSB is made every 16 pixels
When it reaches 255, turns back to 0 and starts again

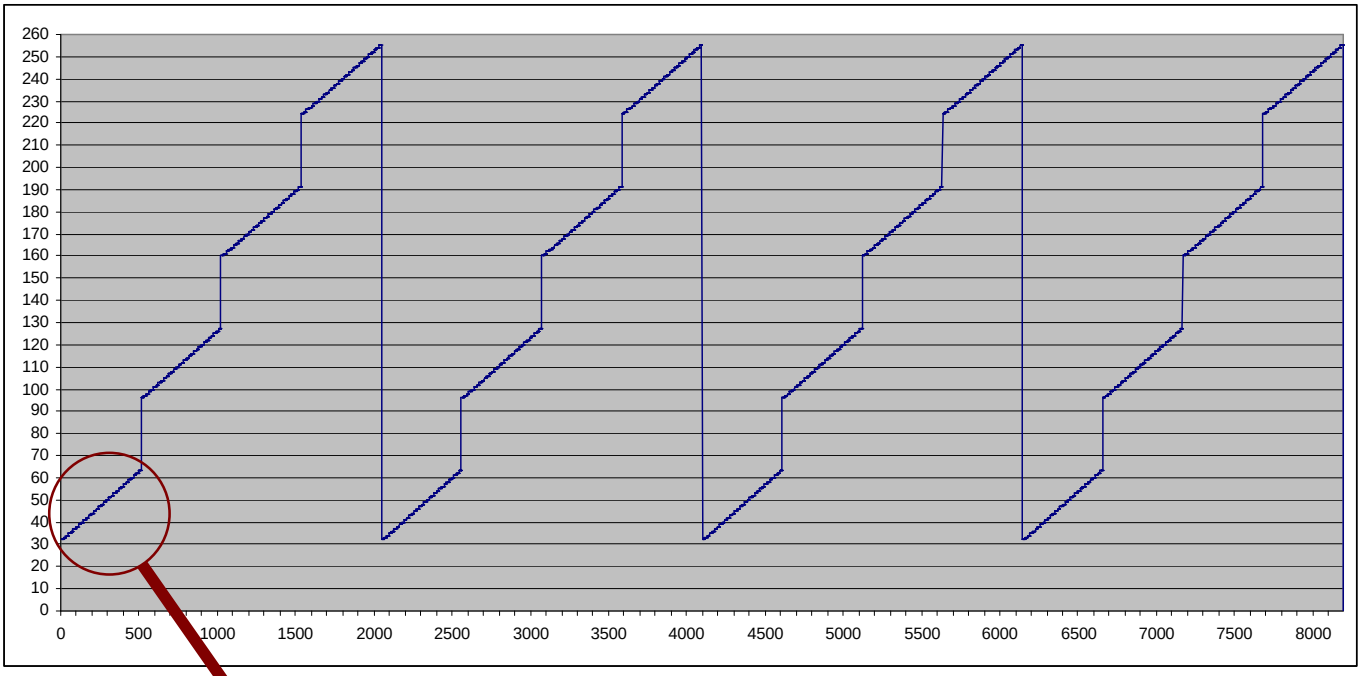
### 7.2.2 In 12 bits (Medium) format – No Binning (16384 pixels)

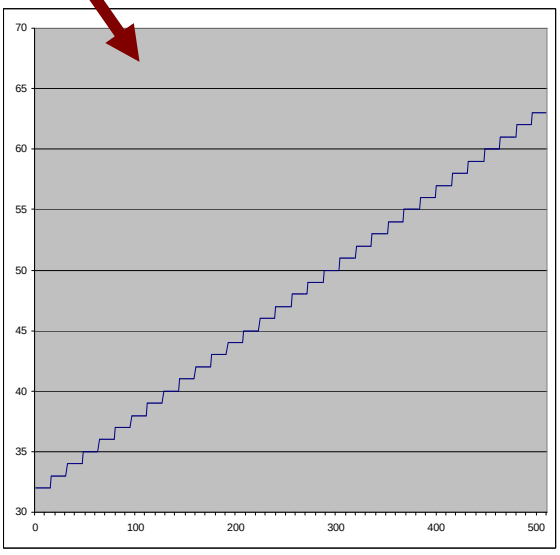



An increment of 1 LSB is made for each pixel. When it reaches 4095, turns back to 0 and starts again

## 7.2.3 In 8/12 bits Full/Medium format with Binning (8192 Pixels)

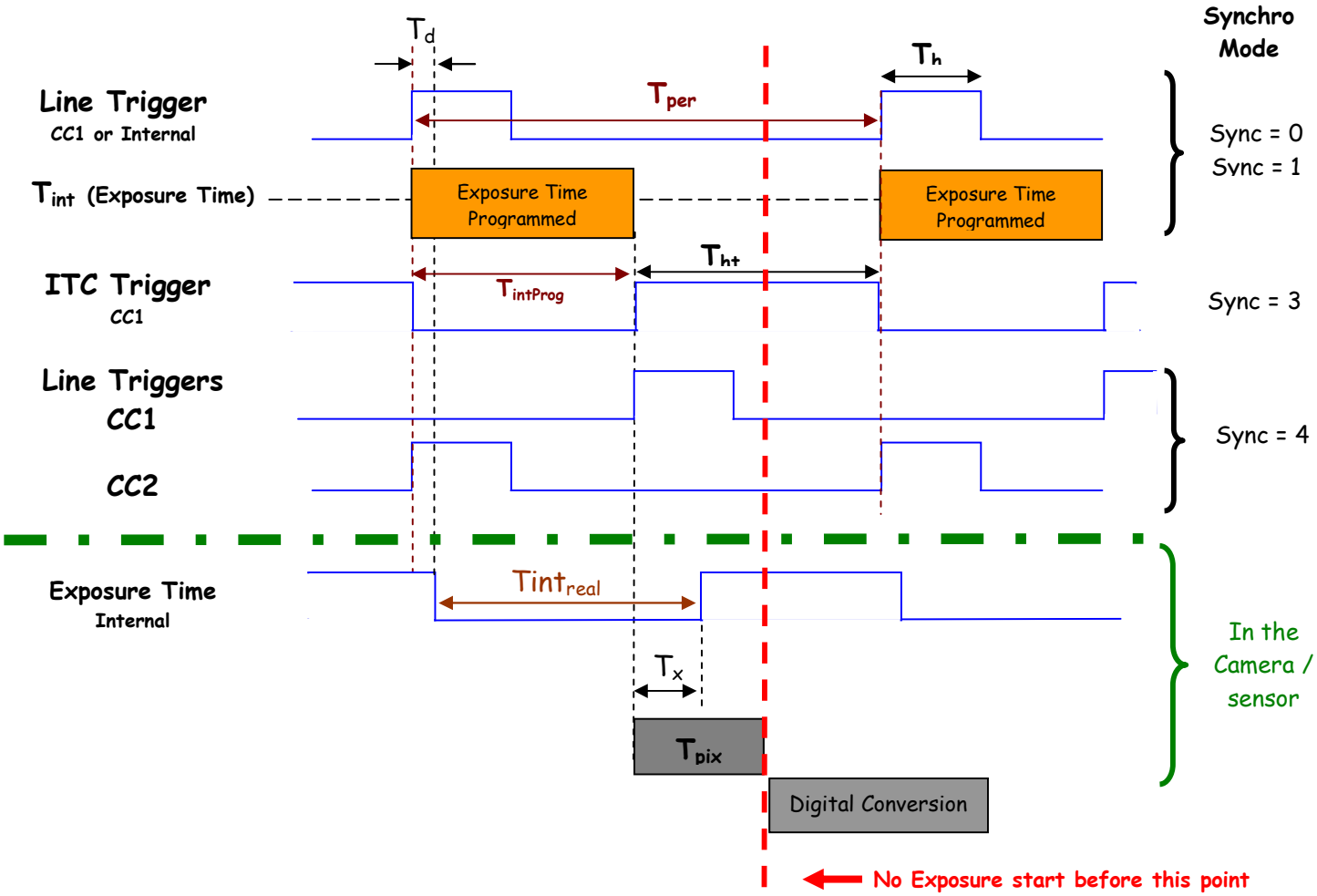



Pixel 0 : 32
Pixel 1 : 32
…
Pixel 15 : 32
Pixel 16 : 33
Pixel 17 : 33
…
Pixel 31 : 33
Pixel 32 : 34
…
Pixel 511 : 63
Pixel 512 : 96
Pixel 513 : 96
…
Pixel 2047 : 255
Pixel 2048 : 32
…

# 8 APPENDIX B: Timing Diagrams

## *8.1 Synchronization Modes with Variable Exposure Time*




**$T_{pix}$** : Timing Pixel. During this uncompressible period, the pixel and its black reference are read out to the Digital converter. During the first half of this timing pixel (read out of the black reference), we can consider that the exposure is still active.

**Digital Conversion** : During the conversion, the analog Gain is applied by the gradient of the counting ramp (see next chapter : Gain & Offset). The conversion time depends on the pixel format :

- 8 or 10 bits : **6µs**
- 12 bits : **24µs**

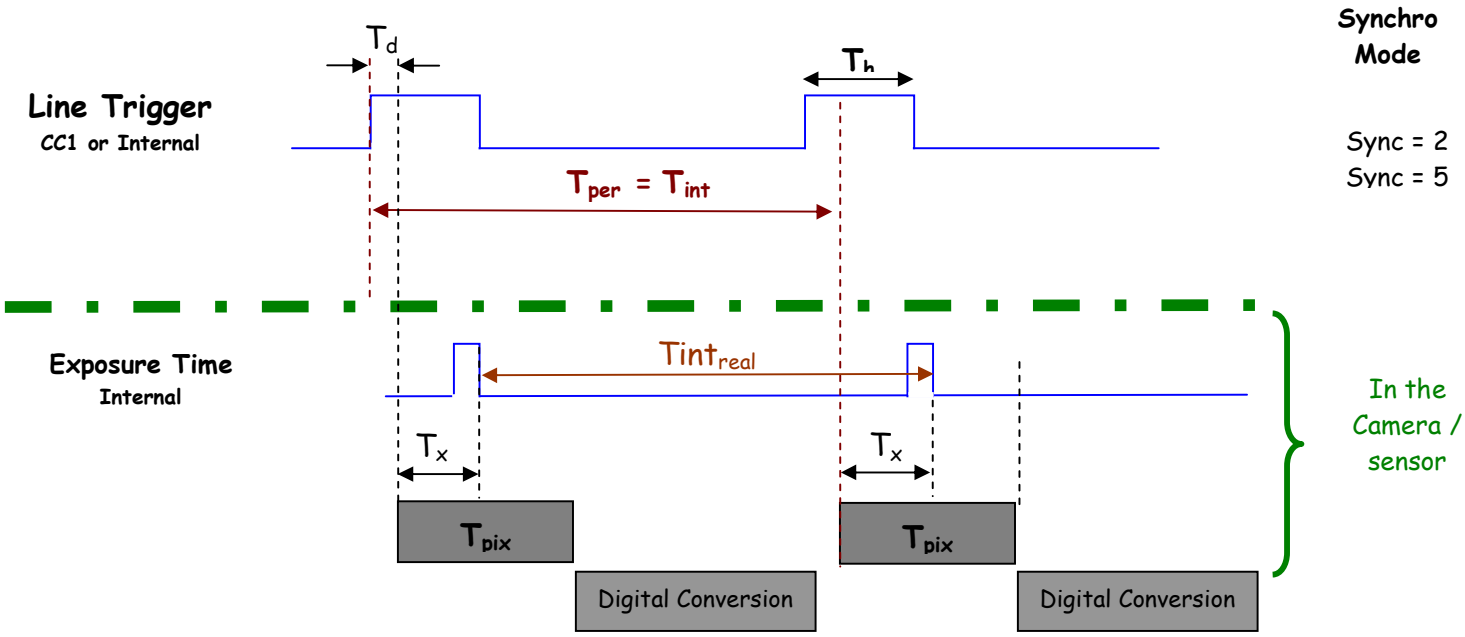
This conversion is done in masked time, eventually during the next exposure period.

**$T_d$** : Delay between the Start exposure required and the real start of the exposure.

*If $T_{per}$ is the Line Period (internal or external coming from the Trigger line), in order to respect this line Period, the Exposure Time as to be set by respecting : $T_{int} + T_{pix} <= T_{per}$*
*Then, the real exposure time is : $Tint_{real} = T_{int} + T_x - T_d$.*
*In the same way, The high level period of the Trig signal in sync=3 mode, $T_{ht} >= T_{pix}$*

For a Line Period of *LinePer*, the maximum exposure time possible without reduction of line rate is : $Tint_{max} = T_{per} - T_{pix}$ ($T_{pix}$ is defined above) but the effective Exposure Time will be about $Tint_{real} = T_{int} + T_x - T_d$.

## 8.2 Synchronisation Modes with Maximum Exposure Time

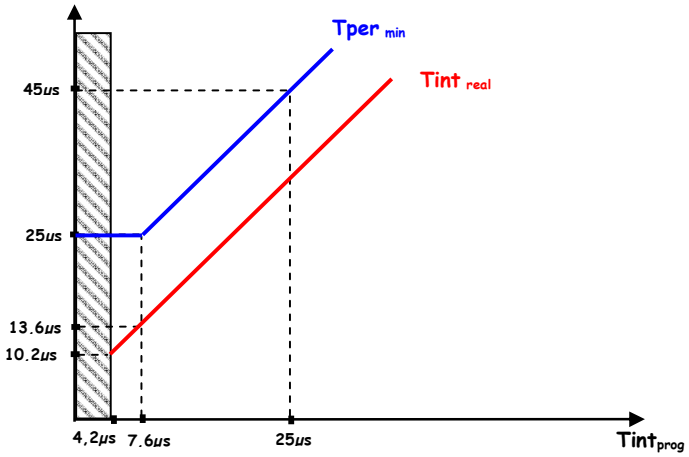



In these modes, the rising edge of the Trigger (internal or External) starts the readout process ($T_{pix}$) of the previous integration. The Real exposure time ($Tint_{real}$) is finally equal to the Line Period ($T_{per}$) even if it's delayed from ($T_x + T_d$) from the rising edge of the incoming Line Trigger.

## 8.3 Timing Values

### 8.3.1 EV71YC4MCL1605-BA0 version

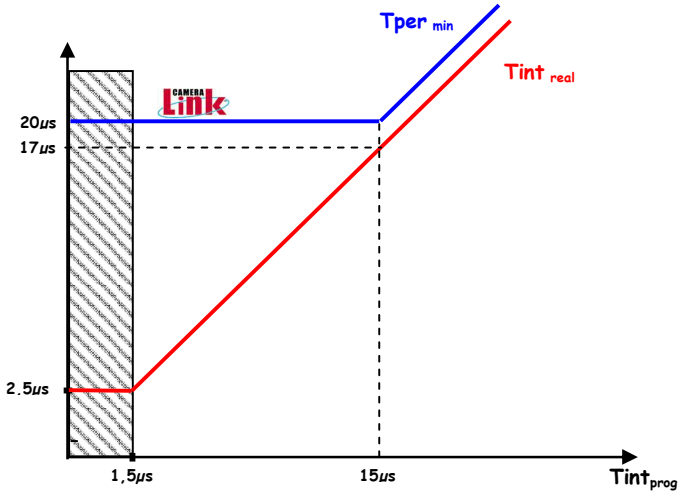
| Label | Min | Unit |
|---|---|---|
| $T_{pix}$ | 17,4 | µs |
| $T_x$ | 9.7 | µs |
| $T_h$ | 0,120 | µs |
| $T_{ht}$ | $T_{pix}$ | µsec |
| $T_{IntProg}$ | 4,2 | µs |
| $T_d$ | 3.69 | µs |



*Due to the high value of the Timing pixel in this EV71YC4MCL1605-BA0 version and the associated limitations, we recommend the use of synchro modes 2 and 5 (maximum exposure time) and then to pulse the light for a exposure control, specially for the highest line rates.*

### 8.3.2 EV71YC4MCL1605-BA1 version

| Label | Min | Unit |
|---|---|---|
| $T_{pix}$ | 5 | µs |
| $T_x$ | 3,1 | µs |
| $T_h$ | 0,120 | µs |
| $T_{ht}$ | $T_{pix}$ | µsec |
| $T_d$ | 1.1 | µs |



# 9 APPENDIX C: Thermal Management

## *9.1 Heat Sink*

The ELIIXA+ is not delivered with an additional : The design of the housing and the low power consumption of the Sensor made it not necessary.

# 10 APPENDIX D: Data Cables

## *10.1 CameraLink*

You may check the compliance of your CameraLink cables with the transportation of the 85MHz data rate : Depending on cable quality, the usual limitation is about 5m long.

Some brands claims for a compliance at up to 7m or more with such a data rate but it has to be certified.

The usual problem encountered with a cable issue is a "snow" around some gray levels (as for a mismatch configuration between 8/10/12 bits). This may also be visible and pointed out by switching the camera on the fixed Test pattern.

# 11 APPENDIX E: Lenses Compatibility

| QIOPTICS (LINOS) | | | | |
|---|---|---|---|---|
| | **Nominal** | **Magnification** | **M95 Focus tube** | **Lens Reference** |
| Inspec.x. L 5.6/105 | **0,33 X** | 0,25 – 0,45 X | 2408-012-000-41 | 0703-085-000-20 |
| Inspec.x. L 5.6/105 | **0,5 X** | 0,4 – 0,65 X | 2408-012-000-41 | 0703-084-000-20 |
| Inspec.x. L 5.6/105 | **0,87 X** | 0,6 – 0,9 X | 2408-012-000-43 | 0703-083-000-20 |
| Inspec.x. L 5.6/105 | **1 X** | 0,85 – 1,2 X | 2408-012-000-43 | 0703-082-000-20 |
| Inspec.x. L 4/105 | **3 X** | 2,8 – 3,3 X | 2408-012-000-46 | 0703-104-000-20 |
| Inspec.x. L 4/105 | **3,5 X** | 3,3 – 3,7 X | 2408-012-000-44 | 0703-095-000-21 |
| Inspec.x. L 3.5/105 | **5 X** | 4,8 – 5,2 X | 2408-012-000-45 | 0703-102-000-20 |

| SCHNEIDER KREUZNACH | | | | |
|---|---|---|---|---|
| | **Nominal** | **Magnification** | **Working Distance (at** | **Reference** |
| SR 5.6/120-0058 | **1 X** | 0,88 – 1,13 X | 212 mm | 1002647 |
| SR 5.6/120-0059 | **0,75 X** | 0,63 – 0,88 X | 252 mm | 1002648 |
| SR 5.6/120-0060 | **0,5 X** | 0,38 – 0,63 X | 333 mm | 1002650 |
| SR 5.6/120-0061 | **0,33 X** | 0,26 – 0,38 X | 453 mm | 1004611 |
| **Accessories** | V mount 25mm macro-extension tube | | Necessary to combine the whole lens system | 20179 |
| | V mount to Leica adapter | | | 20054 |
| | Unifoc 76 | | | 13048 |
| | Adapter M58x0.75 – M95x1 | | | 1062891 |
| | Extension tube M95x1, 25mm | | To be combined to reach the appropriate magnification | 1062892 |
| | Extension tube M95x1, 50mm | | | 1062893 |
| | Extension tube M95x1, 100mm | | | 1062894 |

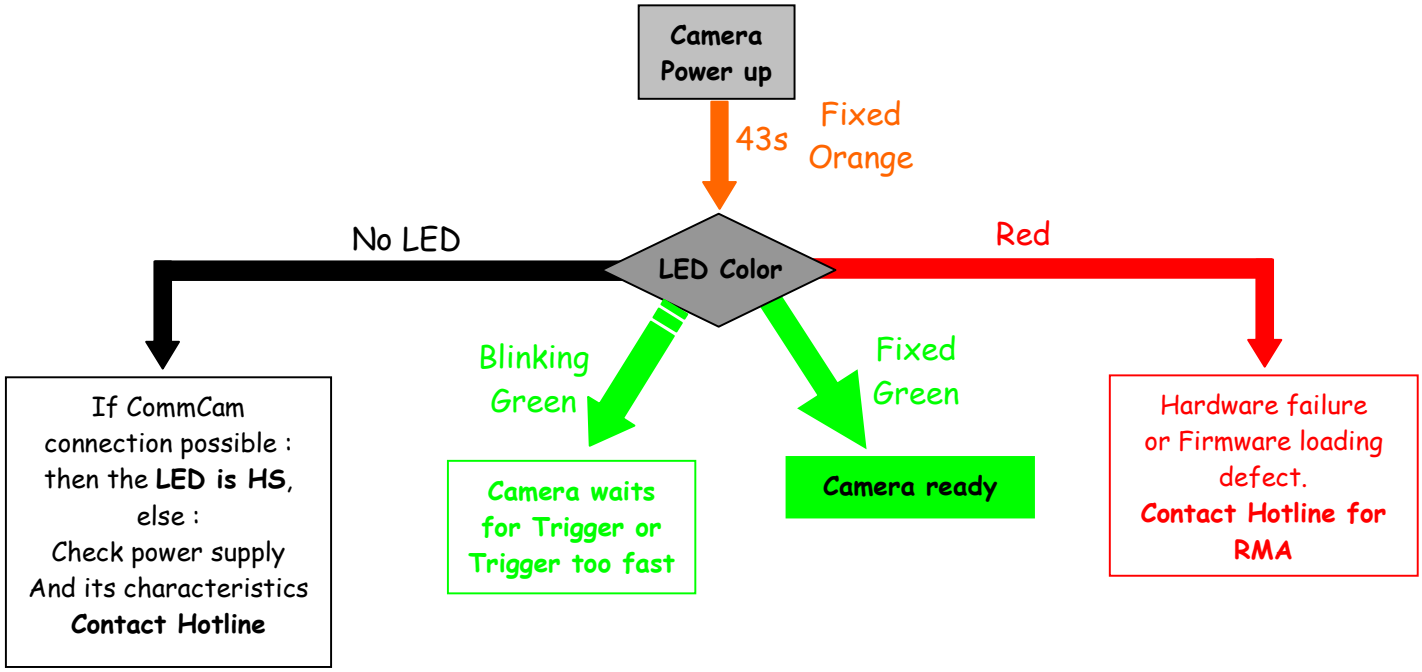
| EDMUND OPTICS | | | |
|---|---|---|---|
| | **Nominal Magnification** | **Working Distance** | **Reference** |
| TechSpec F4 | **1 X** | 151 mm | NT68-222 |
| TechSpec F4 | **1,33 X** | 158,5 mm | NT68-223 |
| TechSpec F4 | **2,0 X** | 129 mm | NT68-224 |
| TechSpec F4 | **3,0 X** | 110 mm | NT68-225 |
| **Accessories** | Large Format Tip/Tilt Bolt Pattern Adapter, 2X | | NT69-235 |
| | Large Format Focusing Module | | NT69-240 |
| | Large Format Adapter Set | | NT69-241 |

| NAVITAR | | | |
|---|---|---|---|
| Raptar Pro 4/86 | **1 X** | Extension Tubes on request | 1 - 17494 |

| NIKON | | | |
|---|---|---|---|
| Rayfact F4 | **0,05 X – 0,5 X** | 1820,4mm – 230,3mm | Rayfact ML90mm F4 |

# 12 APPENDIX F: TROUBLESHOOTING

## 12.1 Camera


Camera Power up
43s
Fixed Orange
No LED
LED Color
Red
Blinking Green
Fixed Green
If CommCam connection possible : then the LED is HS, else : Check power supply And its characteristics Contact Hotline
Camera waits for Trigger or Trigger too fast
Camera ready
Hardware failure or Firmware loading defect. Contact Hotline for RMA

## 12.2 CommCam Connection

Refer to CommCam software Help for the connection issues.

# 13 APPENDIX G: Revision History

| Manual Revision | Comments / Details | Firmware version | 1st CommCam compliant Version |
|---|---|---|---|
| Rev A | First release | 1.0.19 | **2.1.0** |
| Rev B | Timing values and Electro-Optic performances | 1.0.19 | **2.1.0** |
| Rev C | EV71YC4MCL1605-BA1 : New sensor version<br>- Full+ 10 Taps output Mode<br>- 2x Binning modes<br>- New Timing values for the synchro modes<br><br>EV71YC4MCL1605-BA0 : Remains unchanged | 2.x.x<br><br>1.0.19 | **2.2.0**<br><br>**2.1.0** |
| Rev D | Documentation minor changes | 1.0.19 | **2.1.0** |

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